COOPERATIVE
IMPACT ASSESSMENT
REPORT

THE BIOLOGIC AND ECONOMIC ASSESSMENT OF

MEVINPHOS

United States
Department of
Agriculture

In cooperation with

State Agricultural
Experiment Stations

Cooperative Extension
Service

Other State Agencies

U.S. Environmental
Protection Agency

Technical Bulletin
Number XXXX

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MEVINPHOS

A report of the Mevinphos Assessment Team to the Special Review of Mevinphos

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Submitted to the Environmental Protection Agency on August 15, 1989

United States Department of Agriculture

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PREFACE

This report is a joint project of the U.S. Department of Agriculture, the State Land-Grant Universities, and the U.S. Environmental Protection Agency. This report is prepared by a team of scientists from these organizations to provide sound, current scientific information on the benefits of, and exposure to, mevinphos.

The report is a scientific presentation to be used in connection with other data as a portion of the total body of knowledge in a final benefit/risk assessment under the Review process in connection with the Federal Insecticide, Fungicide, and Rodenticide Act as Revised in October 1988.

Sincere appreciation is extended to the Assessment Team members and to all others who gave so generously in the development of information and in the preparation of the report.

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ACKNOWLEDGMENTS

Appreciation is extended to the following people for their assistance in providing information on the uses of mevinphos, acreage treated, production costs, comparative efficiency of mevinphos and available alternative insecticides, the losses associated with inadequate control of the various insect pests, and other related information.

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EXECUTIVE SUMMARY

Mevinphos is a highly toxic organophosphorus insecticide that is registered for use on 109 different sites against a wide variety of pests. It may enter the body by ingestion or by dermal contact; it is absorbed by plant roots, translocated readily to leaves and growing shoots, and degraded rapidly. As a systemic insecticide, it is translocated unchanged. Metabolism does not increase its toxicity. A moderate teratogenic effect was produced when mevinphos was injected into hen eggs before or during the early period of incubation. However, the acute toxicity (oral LD50 for rats is 3.7 to 12 mg/kg; acute dermal LD_{50} for rabbits is 5.3 to 33.8 mg/kg) is of major concern and the trigger for this review.

The principal risk currently known to be associated with mevinphos is that of acute poisoning due to extremely high oral and dermal mammalian toxicity. Poisoning reports from California indicate that mevinphos was among the top five pesticides causing occupational poisoning in the state during 1981-1985. The main avenue of worker applicator exposure was through dermal contact, with more limited inhalation exposure. The California data show 165 mevinphos related poisonings during the period 1980-1986 with an average of 82 poisonings per million pounds of mevinphos used. Because of its high acute toxicity to avian, mammalian and aquatic species, mevinphos is classified as a Category I pesticide.

A questionnaire developed to assess the benefits of mevinphos was designed to elicit key information regarding the present use of mevinphos. Each state was requested to complete a questionnaire for each crop/site for which the pesticide was used in significant quantities. Data were collected relating to the averages of production, costs and use of mevinphos for the crop years 1982-1986. Questionnaires were sent to each of the 50 states plus territories of the United States as well as Washington, DC. Responses were received from all 50 states as well as the Virgin Islands, Guam, Washington, D.C.; and Puerto Rico, and the results serve as the basis of this assessment.

Mevinphos had important commercial use on 33 crops in 25 states. During 1982-1986, an annual average of 666,723 acres were treated with 756,815 pounds of active ingredient of mevinphos. The various use sites include small fruits, citrus, tree fruits and nuts, various vine crops, vegetables, field crops, ornamental plants and sewage systems. The greatest use was on lettuce, followed by uses on strawberry, broccoli, greens (collards, kale, turnip and mustard), cabbage, alfalfa seed, and cauliflower. The amount of mevinphos used on these 7 commodities amounted to 632,751 pounds annually of active ingredient, or 83.6% of the total combined use of mevinphos in the United States during the period covered in the study.

A significant percentage of the total acreage of the following crops grown in the United States was treated with mevinphos: alfalfa seed (69%), broccoli (55%), Brussels sprouts (97%), cabbage (56%), southern pea (83%), cauliflower (67%), celery (51%), greens (75%), cucumber (30%), muskmelons (70%), lettuce (90%), onions (55%), parsley (44%), pepper (47%), strawberry (43%), artichoke (96%), okra (70%) and spinach (62%). Of the 756,815 pounds active ingredient of mevinphos used in the United States, the greatest amount

was used on vegetables (594,777 pounds a.i.), followed by fruits (103,977 pounds a.i.) and field crops (58,061 pounds a.i.). The geographic regions where mevinphos was used in the greatest quantities were the West (445,400 pounds a.i.) and the South (107,035 pounds a.i.), which probably represent treatments on alfalfa for seed production, strawberry, and vegetable crops.

Comparative static equilibrium analysis was used to demonstrate the benefits of mevinphos. The estimated impact of mevinphos use was determined by comparing yields, prices, and production with the expected use of mevinphos's alternatives.

The economic benefits of mevinphos are higher yields and lower costs relative to many other insecticides available for controlling pests on major vegetable and fruit crops. In addition, mevinphos is important in a few major field crops.

The benefits of mevinphos were calculated as the sum of reduced revenues plus added costs that would result from the withdrawal of mevinphos. Presumably, growers are now using mevinphos because it is more profitable than alternative pesticides or control methods.

The yield benefit of mevinphos with respect to price is assumed to be a result of higher supplies and lower prices to consumers. That is, considering total production, the higher yield causes prices to be lower, holding other factors constant. For producers of a commodity exhibiting relatively stable prices, higher production means higher total crop value. At the farm level, opposite changes in production and price are offsetting in celery, lettuce, muskmelons, strawberry, and spinach. Due to the estimated inflexibility of prices for broccoli and especially cauliflower, decreases in U. S. production are not fully offset by increases in price. Therefore, the yield benefit of mevinphos is greater on these two crops compared to the others. The benefit of mevinphos use, based on changes in crop value, totals $59 million. The largest benefit comes from use on cauliflower, followed by broccoli, celery, lettuce, and strawberry.

In addition to the benefit of mevinphos on crop value, the net change in production costs for mevinphos's alternatives amounts to $1.9 million. The major cost increases of substituting chemical and other means to control pests previously controlled by mevinphos would occur on cabbage (+$1.9 million), greens (+$1.6 million) and strawberry (+$1.3 million). Offsetting reductions in costs for substituting mevinphos's alternatives could occur in lettuce (-$1.7 million), alfalfa seed production (-$0.8 million), and cauliflower (-$0.5 million).

The average annual net benefit of mevinphos in U. S. crop production, adding the change in total crop value to the net change in control costs, is $61 million, or about $91 per acre treated. This estimate of total benefit is sensitive to different estimates of yield change and price flexibility. For example, a lower absolute value for price flexibility produces a higher value of any yield benefit from mevinphos use. Also, the net difference in mevinphos's alternative control costs are assumed to be borne entirely by the producer and not passed on to the consumer. The availability of mevinphos is

likely to be a risk reducing (and thus cost reducing) opportunity for producers, suggesting an unmeasured benefit of mevinphos use.

The benefits to consumers of a product treated with mevinphos are assumed to be measured by the difference in retail price that would be paid for the same product treated with mevinphos's alternatives. Based on the farm-level yield and price effects of mevinphos, assuming mevinphos is unavailable and assuming the price change is passed on to the retail level of distribution, consumers benefit from mevinphos use on broccoli, cabbage, cauliflower, celery, greens, cantaloupe and honeydew (other melons), lettuce, strawberry and spinach.

The consumers' total benefit from mevinphos use results from the lower prices paid for total production caused by the lower marginal value of the increased yield. The product of the change in price times the total production of crops whose yield is increased by using mevinphos equals $94 million, comprising broccoli ($4 million), cabbage ($7 million), cauliflower ($3.6 million), celery ($3.7 million), greens ($2.6 million), muskmelons ($1.6 million), lettuce ($65 million), strawberry ($5.6 million), and spinach ($0.9 million).

The total benefit of mevinphos use is the sum of the increased production costs expected with mevinphos's alternatives ($1.9 million), the higher farm value of production ($59 million), and the higher consumer value of production ($94 million). The total benefit of mevinphos use is $155 million.

Of course, in the event that mevinphos is unavailable, higher prices will put pressure on the market to adjust by increasing supply, possibly through increasing imports or through changes in production practices. The analysis presented herein does not attempt to estimate market adjustments; it is intended to indicate where the pressure for adjustment is more likely to occur.

Employment effect might occur in local areas where particular crops are important might occur. These could result from one or both of the following: (1) a crop may no longer be grown in specific local areas if mevinphos is unavailable; and (2) reduction in volumn or shutdown in packing houses and with shippers where the rejection rate for produce due to insect damage becomes high or due to the loss of a crop. These are very important events to the affected individuals and communities, but are fairly minor for individual states or nationally. For the most part, crops on which mevinphos is used (i.e. fresh produce) are produced in areas where soil and climate are favorable for a wide range of crops. Therefore, there are usually alternative uses for land and labor.

Mevinphos is the chemical of choice for many vegetable crops because of its short residual life and quick degradation characteristics which make possible the achievement of legal tolerances within a short pre-harvest interval. This feature is important in all vegetable crops; but is especially critical in artichokes, where the only registered alternative for plume moth control has a 30 day pre-harvest interval; in broccoli during head

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formation; and in other vegetables where harvest is continuous over an interval of several days; in celery, where there is no registered alternative for a broad spectrum of pests at harvest; in okra and in leafy greens, where there is no single alternative superior to mevinphos for a broad spectrum of pests. This is especially true for collards and for spinach, where mevinphos is the only "cleanup" treatment close to harvest and in lettuce, where all the reporting states considered mevinphos the standard for control of aphids and the lepidoperous pest complex.

Mevinphos is either preferred or considered to have an important role in production of green and snap beans, cabbage, carrots, cauliflower, melons, peas, and potatoes. It is not considered essential for production of beets, eggplant, peppers, onions, cucumbers, sweet corn, squash or tomatoes, where alternatives are available. However, for several of these crops, mevinphos is the least expensive and/or the most effective of the registered chemicals. Mevinphos confers sizable yield benefits in production of many vegetables and is considered a valuable tool in resistance management because of its quick action and short residual.

In fruit crops, mevinphos is considered necessary for strawberry production, less so in production of apples and grapes.

KEYWORDS: Mevinphos, Phosdrin, insecticides, pesticide registration, aphids, mites, grasshoppers, Lygus bugs, red-banded leafroller, fruit tree leafroller, orange tortrix, omnivorous leafroller, leaf folder, leafhoppers, strawberry leafroller, salt-marsh caterpillar, Western tussock moth, alfalfa caterpillar, climbing cutworms, alfalfa weevil, cabbage looper, imported cabbage worm, false chinch bug, dipterous leafminer, plume moth, Mexican bean beetle, thrips, tobacco budworm, green stink bug, velvet bean caterpillar, corn earworm, apples, peaches, pears, plums, cherries (sour), oranges, lemons, grapefruit, grapes, raspberries, strawberries, walnuts, alfalfa, clover, corn, sorghum, mustard greens, turnip tops, pea vines, artichoke, beans, beets, broccoli, cabbage, Brussels sprouts, cauliflower, collards, kale, carrots, celery, cucumbers, egg plant, peppers, lettuce, melons, okra, onions, parsley, peas, potatoes, spinach, summer squash, tomatoes, turnips.

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[illegible] fruit tree leaf [illegible]
[illegible]
[illegible]
cutworms, alfalfa weevil, [illegible]
[illegible] chinch bug, [illegible]
beetle, [illegible]
[illegible]
cherries (sour) [illegible]
raspberries, strawberries [illegible]
[illegible] mustard greens, [illegible]
beans, beets, broccoli, cabbage, [illegible]
collards, kale, carrots, celery, [illegible]
lettuce, melons, [illegible]
summer squash, tomatoes, turnips

INTRODUCTION

The Mevinphos Benefits Assessment Team was organized by the USDA, NAPIAP Program in June 1988 for the purpose of developing an accurate, objective summary of the uses and benefits of mevinphos to agricultural productivity in the United States and to examine the economic and social impacts of present and continued use of mevinphos. This benefits assessment was initiated in anticipation of a Special Review of Mevinphos by the United States Environmental Protection Agency. As of July 1989, a Special Review has not been initiated.

Mevinphos is the common name of the insecticidally active chemical 3-[(dimethoxyphosphinyl) oxy] - butenoic acid methyl ester. Mevinphos is a broad spectrum, fast acting, short residual organophosphate insecticide originally developed by Shell Chemical Company in 1953 (Thomson 1977). Its pesticide characteristics are summarized in the report that follows. Other names for mevinphos include Apavinphos, Duraphos, Gestid, Menite, Mevinox, OS-2046, Phosdrin and Phosfene (Thomson 1977, EPA Pesticide Fact Sheet No. 156 {1988}). In the United States, mevinphos is currently produced by AMVAC Chemical Corporation and was marketed by Shell Chemical Company until recently when E. E. DuPont de Nemours and Company acquired license to the Phosdrin 4EC and Phosdrin 1PA4 formulations of mevinphos from Shell. More recently, DuPont has announced that it will not pursue reregistration of mevinphos. AMVAC Chemical Corporation, however, has indicated plans to pursue reregistration of mevinphos for selected agricultural uses (source: Jack Prieur, AMVAC Chemical Corporation, 4100 East Washington Blvd., Los Angeles, CA 90023).

Because mevinphos was developed and initially registered for use as an insecticide more than 30 years ago, and because several companies have been involved, the Assessment Team has been able to develop neither a detailed chronology of registrations, nor an accurate historical picture of mevinphos use. However, through the use of questionnaires sent to all State Pesticide Impact Assessment Liaison Representatives in the United States, we have developed what we believe to be an accurate assessment of the current usage patterns of mevinphos in the United States.

Over the years, mevinphos usage in the United States has averaged between 500,000 and 750,000 pounds active ingredient per year, with the fluctuations being related to variation in acreages of various major use crops, such as lettuce, and in insect pest populations (source: Jack Prieur, AMVAC Chemical Corporation). As of May 1988 there were 134 products containing mevinphos registered in the United States for use on a total of 109 sites (Table 1). Most (98) of these sites were represented by agricultural commodities; but there were an additional 7 sites represented by ornamental plant groups and 4 sites associated with sewage systems. Of the agricultural sites, there were 14 in the fruit and nut grouping, 29 in the forage crop grouping and 55 in the vegetable crop grouping. Responses to our survey questionnaires indicated that mevinphos is currently used on only a small proportion of registered sites. Those uses and the benefits associated with them are discussed in detail in the sections that follow.

INTRODUCTION

Benefits Assessment ... by the ... for the purpose of ... and benefits of mevinphos ... to examine the economic and social impacts ... Special Review of Mevinphos by the United States ... Protection Agency. As of July 1988, a Special ...

Mevinphos is the common name of the insecticidally active compound ... (phosphinyl) oxy] - butenoic acid methyl ester. Mevinphos is a ... action, short residual organophosphate insecticide ... Shell Chemical Company in 1953 (Thomson 1977) ... characteristics are summarized in the Profile that ... Mevinphos include Apavinphos, Duraphos, Menite, Phosdrin ... and Phosfene (Thomson 1977; EPA ... Fact Sheet No. ...). In the United States, mevinphos is currently produced by ... Corporation and was marketed by Shell Chemical Company until ... E. I. DuPont de Nemours and Company acquired license to the ... Phosdrin 100% formulation of mevinphos from Shell ... DuPont has announced that it will not support the registration ... AMVAC Chemical Corporation ... registration of mevinphos for selected agricultural uses ... AMVAC Chemical Corporation, ... East ... Blvd. ... CA 90023)

... was developed and initially registered ... more than 30 years ago, and because several companies have ... the Assessment Team has been able to determine ... of registration ... Through the use of questionnaires ... Extension Representatives ... we believe to be an accurate assessment of the current ... of mevinphos in the United States.

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For insect control on agricultural and ornamental plants, mevinphos is applied as a foliar spray using ground or aerial equipment. Recommended application rates typically range from 0.125 to 1.0 pound a.i./acre but reach 2.0 pounds a.i./acre for control of Western tussock moth larvae, citrus cutworm, variegated cutworm, and pink scavenger caterpillar on citrus (Phosdrin 4EC and Phosdrin IPA4 labels).

The principal risk currently known to be associated with mevinphos is that of acute poisoning due to its extremely high oral and dermal mammalian toxicity (acute oral LD_{50} for rats 3.7 to 12 mg/kg; acute dermal LD_{50} for rabbits 5.3 to 33.8 mg/kg {Wiswesser 1976}). Poisoning reports from California indicate that mevinphos was among the top five pesticides causing occupational poisoning in that state during 1981-1985. The main avenue of worker (applicator) exposure is through dermal contact, with more limited inhalation exposure (EPA Pesticide Fact Sheet No. 156, 1988). The California data show 165 mevinphos related poisonings during 1980-1986, with an average of 82 poisonings per million pounds of mevinphos used. On average, an individual suffering mevinphos poisoning spent 53 days in the hospital (Jay S. Ellenberger, USEPA - presentation at June 28, 1988 Assessment Team Meeting in San Antonio). Because of its high acute toxicity to avian, mammalian and aquatic species, mevinphos is classified as a Category I pesticide.

In the issuance of a Registration Standard, the Environmental Protection Agency (EPA) cited major data gaps in the areas of toxicology, environmental fate, and residue chemistry. Because of extensive data gaps, the EPA has indicated that no significant new uses will be granted until it has received data sufficient to evaluate dietary exposure to mevinphos (EPA Pesticide Fact Sheet No. 156, 1988) In addition the EPA enacted more restrictive re-entry restrictions changing them from "Do not enter treated areas without protective clothing until sprays have dried" (Phosdrin 4EC and Phosdrin 1PA4 labels 1988) to: "four days for citrus groves, grape vineyards and nectarine and peach orchards and 2 days for all other treated areas unless protective clothing specified on the label is worn" (EPA Pesticide Fact Sheet No. 156, 1988).

In the document that follows, we present a description of the methods used by the Assessment Team in acquiring and analyzing data on mevinphos use and benefits followed by a thorough discussion of uses deemed significant based on the amount of crops/acreage treated per year. For each use, we identify the specific target insects and identify potential alternatives to mevinphos use. Finally, we present an analysis of the economic and social impacts of mevinphos use and a discussion of the consequences of mevinphos not being available.

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irrigated cultures [illegible]
(Phosdrin, 1984 Labels).

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[illegible] poisoning [illegible]
[illegible] (indicator) [illegible] is [illegible]
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[illegible] mevinphos use and a discussion of the [illegible]

Table 1. Registered Sites for Mevinphos Use.

<u>Fruit and Nut Crops</u>

Apples (Foliar Treatment)
Cherries (Foliar Treatment)
Cherries (Sour) (Foliar Treatment)
Citrus (Foliar Treatment)
Grapefruit (Foliar Treatment)
Grapes (Foliar Treatment)
Lemons (Foliar Treatment)
Oranges (Foliar Treatment)
Peaches (Foliar Treatment)
Pears (Foliar Treatment)
Plums (Foliar Treatment)
Raspberries (Foliar Treatment)
Strawberries (Foliar Treatment)
Walnuts (Foliar Treatment)

<u>Forage Crops</u>

Alfalfa (Foliar Treatment)
Barley (Foliar Treatment)
Beans (Forage - Fodder) (Foliar Treatment)
Birdsfoot Trefoil (Foliar Treatment)
Celery (Foliar Treatment)
Clover (Foliar Treatment)
Corn (Field) (Forage) (Foliar Treatment)
Corn (Field) (Grain) (Foliar Treatment)
Corn (Forage) (Foliar Treatment)
Corn (Pop) (Foliar Treatment)
Corn (Pop) (Forage) (Foliar Treatment)
Corn (Pop) (Grain) (Foliar Treatment)
Corn (Sweet) (Forage) (Foliar Treatment)
Corn (Foliar Treatment)
Corn (Field) (Foliar Treatment)
Fennel (Foliar Treatment)
Flax (Foliar Treatment)
Oats (Foliar Treatment)
Peas (Foliar Treatment)
Pea Vines (Forage) (Foliar Treatment)
Sesame (Seed Crop Foliar Treatment)
Small Grains (Foliar Treatment)
Sorghum (Foliar Treatment)
Sorghum (Forage) (Foliar Treatment)
Sorghum (Grain)
Sorghum (Grain) (Foliar Treatment)
Wheat (Foliar Treatment)

Table 1 Continued

<u>Vegetable Crops</u>

Artichokes (Foliar Treatment)
Asparagus (Foliar Treatment)
Beans (Foliar Treatment)
Beans (Lima) (Foliar Treatment)
Beans (Green) (Foliar Treatment)
Beans (Snap) (Foliar Treatment)
Beets (Foliar Treatment)
Beets (Greens) (Foliar Treatment)
Broccoli (Foliar Treatment)
Brussels Sprouts (Foliar Treatment)
Brussels Sprouts (Soil Treatment)
Cabbage (Foliar Treatment)
Cantaloupes
Cantaloupes (Foliar Treatment)
Carrots (Foliar Treatment)
Cauliflower (Foliar Treatment)
Chinese Cabbage (Foliar Treatment)
Collards (Foliar Treatment)
Corn (Sweet) (Foliar Treatment)
Corn (Sweet) (Grain) (Foliar Treatment)
Cucumbers (Foliar Treatment)
Eggplant (Foliar Treatment)
Endive (Escarole) (Foliar Treatment)
Honeydew Melons (Foliar Treatment)
Kale (Foliar Treatment)
Lettuce (Foliar Treatment)
Lettuce (Bibb) (Foliar Treatment)
Lettuce (Bibb) (Greenhouse)
Lettuce (Head) (Foliar Treatment)
Lettuce (Leaf) (Foliar Treatment)
Lettuce (Leaf) (Greenhouse)
Lettuce (Romaine) (Foliar Treatment)
Lettuce (Romaine) (Greenhouse)
Melons (Foliar Treatment)
Melons (Soil Treatment)
Muskmelon (Foliar Treatment)
Mustard (Greens) (Foliar Treatment)
Okra (Foliar Treatment)
Onions (Foliar Treatment)
Onions (Dry) (Foliar Treatment)
Onions (Green) (Foliar Treatment)
Parsley (Foliar Treatment)
Peppers (Foliar Treatment)
Potatoes (Foliar Treatment)
Pumpkin (Foliar Treatment)

Table 1 Continued.

Vegetable Crops
Spinach (Foliar Treatment)
Squash (Foliar Treatment)
Squash (Summer) (Foliar Treatment)
Squash (Winter) (Foliar Treatment)
Tomatoes (Foliar Treatment)
Turnips (Foliar Treatment)
Turnips (Greens) (Foliar Treatment)
Turnips (Roots) (Foliar Treatment)
Watercress (Foliar Treatment)
Watermelon (Foliar Treatment)
Ornamental Uses
Bermudagrass (Seed Crop Foliar Treatment)
Ornamental Herbaceous Plants (Foliar Treatment)
Ornamental Plants (Foliar Treatment)
Ornamental Plants (Field) (Foliar Treatment)
Ornamental Woody Shrubs (Foliar Treatment)
Ornamental Woody Vines (Foliar Treatment)
Waterlilies (Foliar Treatment)
Sewage Uses
Sewage Biofilters
Sewage Plants
Sewage Systems
Sewage Systems (Water Treatment)

SYNOPSES OF THE CROPS, PESTS AND USE PARAMETERS FOR MEVINPHOS

FRUIT AND NUT CROPS

Use recommended dosages in sufficient water to obtain thorough spray coverage, but do not exceed indicated maximum gallonage for that crop. If concentrate ground application is employed, do not apply less than 10 gallons of spray per acre, and adjust dosage to obtain same dosage per acre as recommended for full coverage application. Do not apply with hand equipment.

Formulations: 4EC, IPA4, raspberries, 4EC only

Apples/peaches/pears/plums	Aphids, mites, grasshoppers, Lygus bugs, red-banded leafroller

Federal label directions (ground equipment)

Apples/peaches/pears/plums

Aphids and mites - Apply 1/4 to 1/2 pt. (0.125 lb. to 0.25 lb. a.i.) per 100 gal. water, 40 to 800 gal./acre recommended. Do not exceed 1200 gal. of finished spray/acre on apples and plums when 1/2 pt. is used.

Grasshoppers, Lygus bugs and red-banded leafroller - Apply 1/2 to 2/3 pt. (0.25 to 0.33 lb. a.i.) per 100 gal. water, 40 to 800 gal./acre recommended. Do not exceed 900 gal. of finished spray/acre on apples and pears when 2/3 pt. is used. Do not exceed 750 gal. of finished spray /acre on peaches or plums.
Do not treat apples, pears, or plums within 2 days of harvest or peaches within 4 days of harvest or apply more than 5 pts./acre on peaches and plums, 6 1/2 pts/acre on apples and pears.
Peaches only. Workers should not be permitted to enter treated areas to engage in any activity requiring substantial contact with treated foliage for 4 days following treatment. When a mixture of two or more organophosphate pesticides is applied, the re-entry interval shall be extended by adding to the longest applicable interval an additional 50% of that interval.

Cherries (sour only)

Aphids and mites - Apply 1/2 to 2/3 pt. (0.25 to 0.33 lb. a.i.)/100 gal. water.
Do not exceed 750 gal finished spray/acre.
Do not treat within 2 days of harvest or apply more than 5 pt./acre.

Citrus: oranges/lemons/grapefruit	Aphids, fruit tree leafroller, orange tortrix and omnivorous leafroller, Western tussock moth larvae, citrus cutworm,

variegated cutworm, pink scavenger caterpillar

Citrus: oranges/lemons/grapefruit

Aphids - Apply 1 to 2 pt. (0.5 to 1.0 lb. a.i.)/acre in 200 or more gal. water.

Fruit tree leafroller, orange tortrix and omnivorous leafroller - Apply 1 qt. (1.0 lb. a.i.)/acre in 500 gal. water.

Western tussock moth larvae, citrus cutworm, variegated cutworm and pink scavenger caterpillar - Apply 2 qt. (2.0 lb. a.i.)/acre in 1200 gal. water.
Allow at least 7 days between applications. Do not treat within 4 days of harvest. Workers should not be permitted to enter treated areas to engage in any activity requiring substantial contact with treated foliage for 4 days following treatment. When a mixture of two or more organophosphate pesticides is applied, the re-entry interval shall be extended by adding to the longest applicable interval an additional 50% of that interval.

Grapes	Aphids, leaf folder, leafhoppers, mites, red-banded leafroller and Lygus bugs

Grapes

Aphids - Apply 1/2 to 1 pt. (0.25 to 0.5 lb. a.i.)/acre. Do not treat within 2 days of harvest.

Leaf folder, leafhoppers, mites, red-banded leafroller and Lygus bugs - Apply 1 to 2 pts. (0.5 - 1.0 a.i.)/acre. At the 2 pt. dosage do not apply within 5 days of harvest.
Workers should not be permitted to enter treated areas to engage in any activity requiring substantial contact with treated foliage for 4 days following treatment. When a mixture of two or more organophosphate pesticides is applied, the re-entry interval shall be extended by adding to the longest applicable interval an additional 50% of that interval.

Raspberries	Aphids, mites, leafhoppers, fruit tree leafroller and orange tortrix

Raspberries

Aphids - Apply 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.)/100 gal. water, up to 200 gal. water/acre.

Mites, leafhoppers, fruit tree leafroller and orange tortrix - Apply 1/2 to 2/3 pt. (0.25 to 0.33 lb. a.i.) per 100 gal. water, up to 200 gal. water/acre.
Do not treat within 3 days of harvest.

Strawberries — Aphids, mites, grasshoppers, strawberry leafrollers, salt-marsh caterpillar and Lygus bugs

Strawberries

Aphids and mites - Apply 1/4 to 1/2 pt. (0.125 to 0.5 lb. a.i.) per 100 gal. water. Do not treat within 2 days of harvest.

Grasshoppers, Strawberry leafroller, salt-marsh caterpillar and Lygus bugs - Apply 1/2 to 1 pt. (0.25 to 0.5 lb. a.i.) per 100 gal. water.
Do not treat within 2 days of harvest.
For hard-to-kill insects including aphids and mites, use 1 qt./100 gal. water but do not treat within 2 days of harvest or apply more than 1 qt./acre. Do not exceed 100 gal. finished spray/acre.

Walnuts — Aphids, mites, omnivorous looper, orange tortrix, fruit tree leafroller and Western tussock moth

Walnuts

Aphids - Apply 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.)/100 gal. water.

Mites, omnivorous looper, orange tortrix, fruit tree leafroller and Western tussock moth - Apply 1/2 pt. (0.25 lb. a.i.)/100 gal. water.
Do not treat within 2 days of harvest. Do not exceed 1,000 gal. finished spray, or 5 pts./acre.

FIELD CROPS

Formulations: 4EC, IPA4; pea vines, 4EC only

Alfalfa/clover — Aphids, alfalfa caterpillar, grasshoppers, leafhoppers, cutworms (climbing), mites, alfalfa weevil larvae, and Lygus bugs

Federal label directions (ground equipment)

Alfalfa/clover

Aphids and alfalfa caterpillar - Apply 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.) in 10-125 gal. water/acre

Grasshoppers, leafhoppers, cutworms (climbing), mites, alfalfa weevil larvae, and lygus bugs - Apply 1/2 to 1 pt. (0.25 to 0.5 lb. a.i.) in 10-

125 gal. water/acre.
Do not treat within 2 days of harvest.

Corn (field, sweet and popcorn) for forage only.	Aphids

Corn (field, sweet and popcorn) for forage only

Aphids - Apply 1/2 to 1 pt. (0.25 to 0.5 lb. a.i.) in 10-125 gal. water/acre.

Sorghum (for forage and grain)	Aphids, corn earworm, webworm and fall armyworm

Sorghum (for forage and grain)

Aphids - Apply 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.) in 10-125 gal. water/acre.

Corn earworm and webworm - Apply 1/2 to 1 pt. (0.25 to 0.5 lb. a.i.) in 10-125 gal. water/acre.

Fall armyworm - Apply 1 pt. (0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 3 days of harvest.

Pea vines (for forage only)	Aphids, grasshoppers, leafhoppers, mites and cutworms (climbing)

Pea vines (for forage only)

Aphids - Apply 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.) in 10-125 gal. water/acre.

Grasshoppers, leafhoppers, mites and cutworms (climbing) - Apply at 1/2 to 1 pt. (0.25 to 0.5 lb. a. i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

VEGETABLE CROPS

Formulations: 4EC, IPA4; okra and parsley, 4EC only

Federal label directions (ground equipment)

Artichokes	Aphids, plume moth

Artichokes

Aphids - Apply at 1/4 to 1/2 pt. (0.125 to 0.25 lb. a. i.) in 10-125 gal. water/acre.

Plume moth - Apply at 1 to 2 pt. (0.5 - 1.0 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

Beans	Aphids, grasshoppers, leafhoppers, mites and Mexican bean beetle

Beans

Aphids - Apply at 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.) in 10-125 gal. water/acre.

Grasshoppers, leafhoppers, mites and Mexican bean beetle - Apply at 1/2 to 1 pt. (0.25 to 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

Beets (including tops)	Aphids, cabbage looper, cutworm (climbing), dipterous leafminer (adult), false chinch bug, grasshoppers, imported cabbage worm, leafhopper, mites and salt-marsh caterpillar

Beets (including tops)

Aphids - Apply at 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.) in 10-125 gal. water/acre.

Cabbage looper, cutworm (climbing), dipterous leaf miner (adult), false chinch bug, grasshoppers, imported cabbage worm, leafhoppers, mites and salt-marsh caterpillar - Apply at 1/2 to 1 pt. (0.25 to 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 3 days of harvest.

Broccoli, cabbage	Aphids, cabbage looper, imported cabbage worm, grasshoppers, leafhoppers, salt-marsh caterpillar, mites, cutworms (climbing), dipterous leafminer (adult) and Lygus bugs

Broccoli, cabbage

Aphids - Apply at 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.) in 10-125 gal. water/acre.

Cabbage looper, imported cabbage worm, grasshoppers, leafhoppers, salt-marsh caterpillar, mites, cutworms (climbing), dipterous leafminer (adult) and Lygus bugs - Apply at 1/2 to 1 pt. (0.25 to 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

For hard-to-kill insects, including aphids, apply at 1 qt. (1.0 lb. a.i.) in 10-125 gal. water/acre, but do not treat within 3 days of harvest.

Brussels sprouts, cauliflower, collards, kale	Aphids, cabbage looper, imported cabbage worm, grasshoppers, leafhoppers, salt-marsh caterpillar mites, cutworms (climbing), dipterous leafminer (adult) and Lygus bugs

Brussels sprouts, cauliflower, collards, kale

Aphids - Apply at 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.) in 10-125 gal. water/acre.

Cabbage looper, imported cabbage worm, grasshoppers, leafhoppers, salt-marsh caterpillar, mites, cutworms (climbing), dipterous leafminer (adult) and Lygus bugs - Apply at 1/2 to 1 qt. (0.5 to 1.0 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 3 days of harvest.
For hard-to-kill insects, including aphids, apply at 1 qt. (1.0 lb. a.i.) in 10-125 gal. water/acre, but do not treat collards and kale within 7 days of harvest; 3 days on Brussels sprouts and cauliflower.

Carrots	Aphids, leafhoppers, Lygus bugs, mites, cabbage looper, dipterous leafminer (adult), cutworm (climbing), and salt-marsh caterpillar

Carrots

Aphids - Apply at 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.) in 10-125 gal. water/acre.

Leafhoppers, Lygus bugs, mites, cabbage looper, dipterous leafminer (adult), cutworm (climbing), and salt-marsh caterpillar - Apply at 1/2 to 1 pt. (0.25 to 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

Celery	Aphids, dipterous leafminer (adult), Lygus bugs, salt-marsh caterpillar, leafhopper, cabbage looper and mites

Celery

Aphids - Apply at 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.) in 10-125 gal. water/acre.

Dipterous leafminer (adult), Lygus bugs, salt-marsh caterpillar,

leafhooper, cabbage looper and mites - Apply at 1/2 to 1 qt. (0.25 to 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 3 days of harvest.
For hard-to-kill insects, including aphids, use 1 qt. (1.0 lb. a.i.) in 10-125 gal/acre, but do not treat within 5 days of harvest.

Corn (field, sweet and popcorn) for grain only	Aphids

Corn (field, sweet and popcorn) for grain only

Aphids - Apply at 1/4 to 1 pt. (0.125 to 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

Cucumbers (outdoor)	Aphids, grasshoppers, leafhoppers and mites

Cucumbers (outdoor)

Aphids - Apply at 1/4 to 1/2 pt. (0.125 - 0.25 lb. a.i.) in 10-125 gal. water/acre.

Grasshoppers, leafhoppers and mites - Apply at 1/2 to 1 pt. (0.25 - 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

Eggplant, peppers	Aphids, grasshoppers, leafhoppers and mites

Eggplant, peppers

Aphids - Apply at 1/4 to 1/2 pt. (0.125 - 0.25 lb. a.i.) in 10-125 gal. water/acre.

Grasshoppers, leafhoppers and mites - Apply at 1/2 to 1 pt. (0.25 - 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

Lettuce	Aphids, corn earworm, cutworms (climbing), dipterous leafminer (adult), cabbage looper, imported cottage worm, grass-hoppers, mites, Lygus bugs, salt-marsh caterpillar, false chinch bug and thrips

Lettuce

Aphids - Apply at 1/4 to 1/2 pt. (0.125 - 0.25 lb. a.i.) in 10-125 gal. water/acre.

Corn earworm, cutworms (climbing), dipterous leafminer (adult), cabbage looper, imported cabbage worm, grasshoppers, mites, Lygus bugs, salt-marsh caterpillar, false chinch bug and thrips - Apply at 1/2 to 1 pt. (0.25 - 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.
For hard-to-kill insects, including aphids, apply at 1 qt. (1 lb. a.i.) in 10-125 gal. water/acre, but do not treat within 4 days of harvest.

Melons (including cantaloupes, honey-dew melons, muskmelons, watermelons)	Aphids, cabbage looper, imported cabbage worm, dipterous leafminer (adult), leafhoppers, Lygus bugs, mites, false chinch bugs, salt-marsh caterpillars, cutworms (climbing), grass-hoppers; tobacco budworms on watermelon

Melons (including cantaloupes, honeydew melons, muskmelons, watermelons)

Aphids - Apply at 1/4 to 1/2 pt. (0.125 - 0.25 lb. a.i.) in 10-125 gal. water/acre.

Dipterous leafminer (adult), leafhoppers, Lygus bugs, mites, false chinch bugs, and grasshoppers - Apply at 1/2 to 1 pt. (0.25 - 0.5 lb. a.i.) in 10-125 gal. water/acre.

Cabbage looper, salt-marsh caterpillar, cutworms, (climbing) - Apply at 1/2 to 1 pt. (0.25 - 0.5 lb. a.i.) in 10-125 gal. water/acre (except watermelons).

Rindworms (cabbage looper, cutworms, salt-marsh caterpillars, tobacco budworms) on watermelons - Apply at 1/2 pt. in 10-125 gal. water/acre.
Do not treat cantaloupes, honey-dew melons, muskmelons or watermelons within 2 days of harvest.

Okra	Aphids, cutworms (climbing), corn earworms, green stink bug, mites and velvet bean caterpillar

Okra

Aphids - Apply at 1/4 to 1/2 pt. (0.125 - 0.25 lb. a.i.) in 10-125 gal. water/acre.

Cutworms (climbing), corn earworms, green stink bug, mites and velvet bean caterpillar - Apply at 1/2 to 1 pt. (0.25-0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

Onions (including green onions)	Thrips and cutworms (climbing)

Onions (including green onions)

Thrips and cutworms (climbing) - Apply at 1/2 to 1 pt. (0.25-0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

Mustard greens, turnip tops	Aphids, cabbage looper, imported cabbage worm, false chinch bug, dipterous leafminer adult, grasshoppers, leafhoppers and mites

Mustard greens, turnip tops

Aphids - Apply 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.) in 10-125 gal. water/acre.

Cabbage looper, imported cabbage worm, false chinch bug, dipterous leafminer adult, grasshoppers, leafhoppers and mites - Apply 1/2 to 1 pt. (0.25 to 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 3 days of harvest.

Parsley	Aphids

Parsley

Aphids - Apply 1 to 2 pt. (0.5 - 1.0 lb. a.i.) in a minimum of 40 gal. water/acre. For light infestations use lower dosage of 1 pt. (0.5 lb. a.i.). For hard-to-kill insects and increased populations use 2 pt. (1.0 lb.).
Begin application when insects first appear and repeat as often as necessary to maintain control.
Do not treat within 5 days of harvest for the low dosage or within 8 days of harvest for the high dosage. Do not treat more than 3 times between harvests.

Peas (including vines)	Aphids, grasshoppers, leafhoppers, mites and cutworms (climbing)

Peas (including vines)

Aphids - Apply 1/4 to 1/2 pt. (0.125 to 0.25 lb. a.i.) in 10-125 gal. water/acre.

Grasshoppers, leafhoppers, mites and cutworms (climbing) - Apply at 1/2 to 1 pt. (0.25 - 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

Potatoes	Aphids, grasshoppers, leafhoppers, and mites

Potatoes

<u>Aphids</u> - Apply 1/4 to 1/2 pt. (0.125 - 0.25 lb. a.i.) in 10-125 gal. water/acre.

<u>Grasshoppers, leafhoppers and mites</u> - Apply at 1/2 pt. (0.25 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

Spinach	Aphids, cabbage looper, imported cabbage worm, grasshoppers, leafhoppers, mites, dipterous leafminer (adult), cutworms (climbing), salt-marsh caterpillar and false chinch bug

Spinach

<u>Aphids</u> - Apply at 1/4 to 1/2 pt. (0.125 - 0.25 lb. a.i.) in 10-125 gal. water/acre.

<u>Cabbage looper, imported cabbage worm, grasshoppers, leafhoppers, mites, dipterous leafminer (adult), cutworms (climbing), salt-marsh caterpillar and false chinch bug</u> - Apply at 1/2 to 1 pt. (0.25 - 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 4 days of harvest.
For hard-to-kill insects, including aphids, apply at 1 qt. (1 lb. a.i.) in 10-125 gal. water/acre, but do not treat within 7 days of harvest.

Summer squash	Aphids, cabbage looper, dipterous leafminer (adult), leafhoppers, Lygus bugs, mites, false chinch bugs, salt-marsh caterpillar, cutworms (climbing), and grasshoppers

Summer squash

<u>Aphids</u> - Apply at 1/4 to 1/2 pt. (0.125 - 0.25 lb. a.i.) in 10-125 gal. water/acre.

<u>Cabbage looper, dipterous leafminer (adult), leafhoppers, Lygus bugs, mites, false chinch bugs, salt-marsh caterpillar, cutworms (climbing), and grasshoppers</u> - Apply at 1/2 to 1 pt. (0.25 - 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

Tomatoes (outdoor)	Aphids, grasshoppers, leafhoppers and mites

Tomatoes (outdoor)

Aphids - Apply at 1/4 to 1/2 pt. (0.125 - 0.25 lb. a.i.) in 10-125 gal. water/acre.

Grasshoppers, leafhoppers and mites - Apply at 1/2 to 1 pt. (0.25 - 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 2 days of harvest.

Turnips	Aphids, cabbage looper, imported cabbage worm, grasshoppers, leafhoppers, mites, false chinch bug and dipterous leafminer (adult)

Turnips

Aphids - Apply at 1/4 to 1/2 pt. (0.125 - 0.25 lb. a.i.) in 10-125 gal. water/acre.

Cabbage looper, imported cabbage worm, grasshoppers, leafhoppers, mites, false chinch bug and dipterous leafminer (adult) - Apply at 1/2 to 1 pt. (0.25 - 0.5 lb. a.i.) in 10-125 gal. water/acre.
Do not treat within 3 days of harvest.

GREENHOUSE

Diluted PHOSDRIN 4 EC should be applied in a closed greenhouse (close all doors, windows and ventilators). Lock or barricade all entrances, post warning signs, and take whatever precautions are necessary to prevent unprotected humans and domestic animals from entering the treated area. The operator must wear a full-face mask of a type found adequate for mevinphos (PHOSDRIN Insecticide) protection.

Apply any time the greenhouse ventilators can remain closed for two hours without endangering crops from high temperatures, such as early morning, cloudy days or late afternoons. If application is made during the day, keep the greenhouse closed tightly for at least two hours, then ventilate the enclosure thoroughly for an hour before resuming regular work. If application is made in the late afternoon, the house can be kept closed all night. On the following morning, ventilate for one hour to render the air safe for regular work.

Lettuce (including leaf, bibb and romaine)

Aphids, corn earworms, cutworms (climbing), dipterous leafminer (adult), cabbage looper, imported cabbage worm, grasshoppers, mites, Lygus bugs, salt-marsh caterpillars, false chinch bugs and thrips - Apply 1 1/4 to 2 1/3 pt. (0.625 - 1.155 lb. a.i.) diluted, per 50,000 sq. ft.
Do not treat within 10 days of harvest.

AERIAL APPLICATION

Vegetable and Field Crops

General - Apply at rates indicated, to vegetables and crops as listed above. Use 5-20 gallons water/acre.

Parsley	Aphids

Parsley

Aphids - Apply Phosdrin 4EC, 1 to 2 pt., (0.5 - 1.0 lb. a.i.) in 5-20 gallons water/acre. For light infestations use the lower dosage.
Do not treat within 5 days of harvest.
For hard-to-kill insects and increased populations use the higher dosage.
Do not treat within 8 days of harvest.
Begin application when insects first appear and repeat as often as necessary to maintain control.
Do not treat more than 3 times between harvests.

Fruit and Nut Crops

Grapes	Aphids, leaf folder, leafhoppers, mites, red-banded leafroller and Lygus bugs

Grapes

Aphids - Apply at 1/2 to 1 pt. (0.25 - 0.5 lb. a.i.) in 7-25 gal. water/acre.
Do not treat within 4 days of harvest.

Leaf folders, leafhoppers, mites, red-banded leafroller and Lygus bugs-
Apply at 1 to 2 pts. (0.5 - 1.0 lb. a.i.) in 7-25 gal. water/acre.
At the 2 pt. dosage do not treat within 5 days of harvest.

Orchard Crops

General - Apply at rates indicated, to fruit and nut crops listed above. Use 10-20 gallons water/acre.

PESTICIDE CHARACTERISTICS

Mode of Action

Mevinphos is highly toxic, and may enter the body by ingestion or by dermal contact. It is a cholinesterase inhibitor (EPA 1988, Hayes 1982) which acts directly, as differentiated from others which are not active until they have been altered by chemical or enzymatic action (Doull 1976).

Physical and Chemical Properties

Mevinphos exists in two isomeric forms, the E or cis-crotonate isomer sometimes designated alpha, and the Z or trans-crotonate, designated as the beta isomer. The two differ in NMR spectra, melting point, stability, and toxicity to insects and mammals (Fukuto et al 1961, Hayes 1982). The E-isomer is about 100 times more toxic to both insects and mammals than the Z-isomer (Cremlyn 1978). The empirical formula is $C_7H_{13}O_6P$, with a molecular weight of 224.16. Preparation is described by A. R. Stiles (U. S. pat. 2,685,552 to Shell 1954). Technical mevinphos is a pale yellow to orange liquid with a mild odor or without odor. The boiling point ranges from 99 - 103°C at 0.03 mm Hg. The E-isomer has a melting point of 21°C, the Z- of 6.9°C. The density is 1.24 at 16°C, with densities of the two isomers 1.2345 and 1.245, respectively. The vapor pressure is 0.003 mm Hg at 21°C. Most commercial products contain about 60% E- and 30% Z-isomer. The technical material is miscible with water, alcohols, ketones, chlorinated hydrocarbons, and aromatic hydrocarbons, but is only slightly soluble in aliphatic hydrocarbons. It is stable at ordinary temperatures. Mevinphos is hydrolyzed in water with a half-life of 1.4 hours at pH 11, 3 days at pH 9, 35 days at pH 7, and 120 days at pH 6. Lime sulphur results in rapid decomposition (EPA 1988, Hayes 1982). The cis-isomer is hydrolyzed faster than the trans, at pH 11 and 28°C the half-life is 1.8 and 3.0 hr respectively (Gatterdam et al 1959). Exposure to UV will increase the proportion of the trans-isomer (Casida 1955).

Formulations Marketed

Mevinphos has been marketed in the past as a dust, emulsifiable concentrate, soluble concentrate/liquid, and as a ready to use formulation. It is now marketed as an emulsifiable concentrate at 4 lb. per gallon, or as a solution in isopropyl alcohol at 4 lb. per gallon (EPA 1988).

Physiological Activity in Soil or Plant and Animal Tissue

Mevinphos is absorbed by plant roots, translocated readily to leaves and growing shoots, and degraded rapidly (EPA 1988). Mevinphos as a systemic insecticide is translocated unchanged. Metabolism does not increase its toxicity (Eto 1974). The major residues found in plants are the E- and Z-isomers of mevinphos and dimethyl phosphate. Mevinphos acid is a minor metabolite in plants, which is converted to desmethyl mevinphos acid (EPA 1988). In cows dimethyl phosphate is the primary metabolite in the urine, other hydrolysis products are found in the feces (Matsumura 1985). The E-

isomer is readily degraded by the mouse liver glutathione S-alkyltransferase (Morello et al 1968). The Z-isomer is not demethylated, but is degraded by esterases splitting the vinyl ester linkage (Spencer 1972).

A moderate teratogenic effect was produced when mevinphos was injected into hen eggs before or during the early period of incubation (Eto 1974).

The acute oral LD_{50} for rats is 4 to 7 mg/kg (Eto 1974). In a study in which rats were fed 110 ppm mevinphos, all died within 3 weeks. At 50 ppm for 60 days, rats showed reduced growth, slight tremor, and brain cholinesterase 20% of normal. At 6.3 ppm, rats showed slight tremor and brain cholinesterase 90% of normal (Kodama et al 1954). Dogs fed at a dietary level of 5 ppm (ca. 0.1 mg/kg/day) for 14 weeks showed erythrocyte and plasma cholinesterase levels reduced to 70 and 90% of controls, respectively (Cleveland & Treon 1961). Animal metabolism data indicate that twelve hours after dosing 57 to 65% of the 32P-residue was excreted, 45-50% in the urine and 12-15% in the feces, and only mevinphos hydrolysis products were present (EPA 1988).

In an experiment using human volunteers, a dose of 2.5 mg/man/day (ca. 0.036 mg/kg/day) produced a maximal decrease of 25% in red blood cell (RBC) cholinesterase by the 27th day, but did not affect plasma cholinesterase activity or result in any other symptoms. Dosages of 1.5 and 2.0 also reduced RBC cholinesterase, whereas a dose of 1.0 for 30 days produced no detectable effect. After dosing was stopped, return of RBC cholinesterase to normal was determined entirely by the rate of replacement of red cells (Rider et al 1972, 1975). Accidental poisoning may result in the rapid appearance of symptoms. In more than one instance this has involved the impairment of judgement (Hayes 1982), which is not explained by studies in animals that indicate that penetration of mevinphos into the brain is slow and limited, and that brain cholinesterase is less susceptible than the enzymes derived from plasma and red cells (Sharma et al 1973). Other accident reports have shown that symptoms may be delayed until 48 hours after last exposure (Roche et al 1961).

METHODOLOGY OF THE BENEFITS ASSESSMENT STUDY

A questionnaire was developed to assess the benefits of mevinphos (see APPENDIX I). This questionnaire was designed to elicit key information regarding the present use of mevinphos. Each state was requested to complete a questionnaire for each crop/site for which the pesticide was used in significant quantities. Data were collected relating to the averages of production, costs, and use of mevinphos for the crop years 1982-1986. Questionnaires were mailed to each State Pesticide Liaison Representative on July 19, 1988. Questionnaires were sent to each of the 50 states plus territories of the U.S. (Virgin Islands, Guam, Puerto Rico) as well as Washington, D.C.

Responses were received from all 50 states, as well as the Virgin Islands; Guam; Washington, DC; and Puerto Rico. Mevinphos had important commercial use on 33 crops in 25 states. Survey responses by commodity and U. S. production by commodity are given in APPENDIX II.

Reporting states used a variety of methods to complete the questionnaires. In some states (notably Florida), all responses were formulated by a single individual working under the supervision of the State Pesticide Liaison Representative. At the other end of the spectrum, some State Liaison Representatives sent the questionnaire to extension agents and/or industry field men in key production areas. In these cases, a single individual may have responded for one or several sites. Other states fell in between these two extremes.

Rules were established to deal with missing data. In general, production data (yields, acres, prices) were used for the affected crops as reported by respondents. Major adjustments to account for missing or inaccurate data were as follows:

a) All production data as given by the respondents were used when it appeared to be reasonable. Internal checks were run by converting all production data to hundredweight and computing price per hundredweight and revenue per acre. In this manner all "unreasonable" data were checked against other data sources such as the National Agricultural Statistics Service (NASS) and the Economic Research Service.

b) When missing data were encountered, we used NASS data where available for crop production, acreage, prices, etc. Missing data on yield changes and alternative control costs were taken from similar sites in the same region.

c) Some sites were eliminated where the crop or mevinphos use was very minor.

d) When respondents reported ranges, we took the mid-point of the range.

All survey adjustments are reported in Appendix III.

Survey responses are summarized in Tables 2 and 3. The 33 crops on which mevinphos is used in significant quantities are indicated in Table 2. A total of 130 questionnaires were used in the analysis. These crops account for 2.9 million acres in production. Mevinphos was used on about 667,000 acres, or 23 percent of the total acreage of these crops. The largest use in terms of acreage was (1) lettuce (209,500 acres or 90 percent of lettuce acreage); (2) alfalfa seed (92,800 acres or 69 percent of alfalfa seed acreage); and (3) broccoli (61,892 acres or 55 percent of broccoli acreage).

The crops on which mevinphos is used accounted for an aggregate value of production of $4.8 billion (Table 3).

Table 2. Survey responses: States reporting, acreage, and acreage treated with mevinphos (average annual), 1982-86.

Crop	States reporting	Acreage reported in production	Acreage reported treated	Acres treated (percent)
Alfalfa seed	CA,OR,WA	133,862	92,800	69
Apple	IL,NJ,NY	83,680	4,740	6
Broccoli	AL,CA,FL,NJ OR,TX	112,622	61,892	55
Brussels sprouts	CA	3,094	3,000	97
Cabbage	AL,CA,DE,FL, GA,IL,NC,NJ,NY SC,TX,UT,WI	83,158	46,310	56
Pea, southern	TN	300	250	83
Carrot	FL,OR,WI	15,060	3,535	23
Cauliflower	CA,FL,NJ,OR,TX	51,337	34,400	67
Celery	CA,FL,MI	30,973	15,743	51
Greens	AL,AZ,FL,GA,IL, LA,MD,NJ,NY,NC, LA,OK,TN,TX,VA	33,142	24,985	75
Corn, field	CO,FL	706,200	820	--
Corn, sweet	FL	67,020	12,712	19
Cucumber	FL,GA,NJ,TX,OR	33,280	10,126	30
Eggplant	FL,NJ	3,396	401	12
Grape	CA	676,700	11,419	2
Muskmelons	CA,FL,GA,NC, NJ,TX	55,230	38,463	70
Lettuce	AZ,CA,CO,FL,MI, NJ,NY,TX,WI	233,496	209,500	90
Onion (all)	CA,FL,OR,WI	10,110	5,550	55
Parsley	FL	910	400	44
Pea, english	WI	88,140	500	1
Pepper	FL,NJ,TN,TX	38,100	17,769	47
Potato	FL,ID	32,900	658	2
Sorghum	FL	45,045	1,700	4
Squash	FL,GA	25,360	4,650	18
Strawberry	FL,NJ,CA	19,102	8,177	43
Tomato	AR,FL,NJ,TX	58,370	6,922	12
Turnip	FL	1,199	200	17
Artichoke	CA	10,417	10,000	96
Bean, lima	FL	242	23	10
Bean, snap	AR,FL,NC,TN,WI	142,497	10,169	7
Okra	FL	2,440	1,855	76
Spinach	MD,NJ,NY,FL,VA, OK,TX,CA	22,299	13,910	62
Watermelon	NJ,FL,GA,NC	109,610	13,145	12
Total		2,929,291	666,723	23

Table 3. Survey responses: Acreage, production, value (average annual), 1982-1986.

Crop	Acreage	Production (1,000 cwt.)	Value of production: Total (1,000 dollars)	Average dollars (per cwt.)	Average dollars (per acre)
Alfalfa seed	133,862	1,085	105,390	97.13	787
Apple	83,680	12,585	135,530	10.77	1,620
Broccoli	112,622	10,570	260,034	24.60	2,309
Brussels sprouts	3,094	294	9,226	31.41	2,982
Cabbage	83,518	24,601	184,248	7.49	2,216
Pea, southern	300	10	185	18.97	617
Carrot	15,060	2,699	20,865	7.73	1,385
Cauliflower	51,337	5,380	134,364	24.97	2,617
Celery	30,973	10,923	138,292	12.66	4,465
Greens	33,142	4,874	110,569	22.68	3,336
Corn, field	706,200	66,735	296,925	4.45	420
Corn, sweet	67,020	6,997	83,894	11.99	1,252
Cucumber	33,280	4,717	64,163	13.60	1,928
Eggplant	3,396	706	11,289	15.98	3,324
Grape	676,700	49,315	1,043,366	21.16	1,542
Muskmelons	55,230	7,967	105,199	13.20	1,905
Lettuce	233,496	67,218	783,094	11.65	3,354
Onion	10,110	5,144	44,414	8.63	4,393
Parsley	910	142	4,162	29.31	4,574
Pea, english	88,140	2,643	25,737	9.74	292
Pepper	38,100	4,201	109,272	26.01	2,868
Potato	32,900	7,486	66,227	8.85	2,013
Sorghum	45,045	8,394	10,969	1.31	244
Squash	25,360	2,946	44,098	14.97	1,739
Strawberry	19,102	7,555	332,503	44.01	17,407
Tomato	58,370	35,021	396,046	11.31	6,785
Turnip	1,199	---	---	---	---
Artichoke	10,417	795	30,838	38.77	2,960
Bean, lima	242	8	513	64.13	2,120
Bean, snap	142,497	6,656	79,869	12.00	560
Okra	2,440	83	2,829	34.08	1,159
Spinach	22,299	2,857	54,761	19.17	2,456
Watermelon	109,610	12,604	78,516	6.23	716
Total	2,929,291		4,767,386		1,626

EXTENT OF USE

Mevinphos was registered for use on 109 different sites as of May 9, 1988 (Table 1). The various use sites include small fruits, citrus, tree fruits and nuts, various vine crops, vegetables, field crops, ornamental and sewage systems. During the 1982-86 use period, 666,723 acres (Table 2) of 33 various agricultural commodities were treated with a total of 756,815 pounds of mevinphos active ingredient (Table 34).

The greatest use was on lettuce (241,748 lbs a.i.) followed by uses on strawberry, broccoli, greens, cabbage, alfalfa seed, and cauliflower. The amount of mevinphos used on these 7 commodities was 632,751 lbs a.i. or 83.6 % of the total combined use on all other crops that reported use in the United States. A significant percentage of the total United States acreage of the following crops was treated with mevinphos: alfalfa seed (69%), broccoli (55%), Brussels sprouts (97%), cabbage (56%), southern pea (83%), cauliflower (67%), celery (51%), greens (75%), cucumber (30%), muskmelons (70%), lettuce (90%), onions (55%), parsley (44%), pepper (47%), strawberry (43%), artichoke (96%), okra (70%), spinach (62%), and watermelon (23%) (Table 2).

Of the total 756,815 lbs a.i. of mevinphos used in the U.S., the greatest amount was used on vegetables (594,777 lbs), followed by fruits (103,977 lbs), and field crops (58,061 lbs), (Table 34).

Geographic regions in the U.S. that reported the greatest mevinphos usage were the West (445,400 lbs a.i.) and the South (107,035 lbs a.i.). This probably represents treatments on strawberry and vegetable crops.

Until alternative materials and methods are developed that are equal to or better than mevinphos and have a short pre-harvest interval, the foreseeable use patterns will probably stay about the same. That is, a significant percent of the strawberry and certain vegetable acreage will continue to use mevinphos, whereas most of the field and fruit crops are currently using safer and more cost-effective pesticides and will probably continue to do so.

The average annual use of mevinphos, 756,815 pounds active ingredient, which was estimated from the surveys is above the indicated usage in the United States which has averaged 500,000 to 750,000 pounds active ingredient per year. This could result from several factors. Entomologists, extension specialists, and industry personnel who responded to the survey may have based their estimates of use on events or years which were extremes rather than averages for the period 1982-1986. Furthermore, their contacts may tend to be based on more progressive grower or growers who are more aware of particular insect problems. Apparently the estimate is about 21 per cent above actual use. The committee believes that our estimate is defendable given the inevitable data limitations, time and funding available for this study.

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SPECIFIC USE ANALYSIS

FRUIT AND NUT CROPS

The results of our survey questionnaire suggest that mevinphos is currently being used only on apples, grapes, and strawberries in the United States, although it is registered for use on nine other fruit/small fruit/nut crops. It was reported as being used against leafrollers (redbanded, obliquebanded and variegated), mites and fruitworms (green and sparganothis), aphids, Lygus bugs and codling moth on apples; grape leafhopper, mites and grape leaffolder on grape and aphids, mites and strawberry leafroller on strawberry.

Leafrollers. Damage to apple is caused by the larval stage. Larvae are indiscriminate feeders with most serious injury occurring around petal fall and shortly after when developing fruit is damaged. Fruit damaged at this stage usually drops prematurely, but some remains on the tree and develops deep corky scars and indentations by harvest. Although the larvae are primarily foliage feeders, they often feed on the surface of the fruit during the season (Reissig 1980, Metcalf et al. 1962). If not controlled, 80-90% of the crop may be damaged in years of abundance (Metcalf et al. 1962).

Mites. Two species, the European red mite and the twospotted spider mite, are pests of apples. All motile stages of both species feed on individual leaf cells removing the contents, including the chlorophyll. The injury results in off-color foliage. The leaf efficiency and productivity is reduced significantly. Heavy feeding in June and July reduces tree growth and yield and can drastically affect fruit bud formation reducing yield the following year (Metcalf et al. 1962, Lienk 1980).

Fruitworms. This complex is an early season pest of apples. Most damage is observed within 3 - 4 weeks after petal fall. The larval stage feed on the developing fruit. Often, the whole side of an apple is consumed. A single larva will severely damage several fruit on a branch. Often the fruit will remain on the tree. At harvest it is worthless (Metcalf et al. 1962).

Aphids. The major aphid pest of apple is the rosy apple aphid. It is an early season pest found on the trees from bud-break until late spring. Feeding on the foliage causes severe distortion of the leaves. Feeding on the leaves of fruit clusters often results in bunching, stunting, and malformation of the fruit. This becomes noticeable as the fruit develops and renders it unmarketable. Honeydew produced by the aphids provides a media for sooty mold fungus growth. This can affect fruit finish. Populations levels fluctuate and can cause significant fruit loss if not controlled (Wieres and Leeper 1980). The apple aphid and the spirea aphid also are pests. Both of these species remain on the tree throughout the season. Their feeding does not cause leaf curling or fruit distortion. However, the copious amounts of honeydew produced by these aphids provides a media for the growth of sooty mold with the same results as described for the rosy apple aphid (Metcalf et al. 1962).

Lygus bugs. These insects all have piercing-sucking type mouthparts which are inserted into the plant material. A toxic saliva is injected during the feeding process which kills the plant cells in the immediate area. On apple, this may cause abortion of the developing fruit bud or, if shortly after bloom, it causes a deeply depressed area in the fruit. Numbers can vary considerably from year-to-year, but considerable damage occurs if no controls are applied at pink and petal fall (Metcalf et al. 1962).

Codling moth. The larval stage enters the side or blossom end of the apple fruit and tunnels in to the core. The seeds and core are eaten by the larvae rendering the fruit unsuitable for human consumption. Small larvae may partially enter the fruit after pesticide treatment and produce "stings" which reduce the fruit grade. If left uncontrolled, 20 - 90% of the fruit may be infested by this pest (Metcalf et al. 1962).

Grape leafhopper. Both adults and nymphs feed on grape foliage and puncture individual cells and remove the contents. Feeding punctures leave a white spot. This appears on the foliage and fruit. Heavy feeding on the leaves reduces photosynthetic activity. Vines can withstand 20% defoliation a month after fruit set without adverse yield affect. Excessive fruit spotting on table grapes can lead to economic loss before any effect on soluble solids or yield is noted. Adults and nymphs are annoying to pickers when populations are high (Jensen and Flaherty 1981a). In some instances, extremely high populations may reduce the quantity of fruit harvested by as much as 30% (Metcalf et al. 1962).

Spider mites. The Pacific spider mite is the primary pest species while the Willamette spider mite occasionally causes problems and the twospotted spider mite is only occasionally found on grapes. Both the Pacific and Willamette mites cause chlorosis of the leaves while high densities of the Pacific mite can cause shoot tip distortion.

Pacific mites can affect fruit quality or maturity due to the loss of productive leaf surface. The following year vine growth and crop may also be affected. Occasionally, heavy populations of Pacific mites have killed grape vines.

Willamette mites seldom produce economic damage to grapevines. Spotty damage may occur in the spring when high numbers overwinter (Flaherty et al. 1981).

Grape leaffolder. Injury to grapes is caused by the larval stage. The primary damage is by rolling and feeding on the leaves which reduces the photosynthetic function. Extreme population densities may feed on fruit, but economic damage usually occurs only with massive, late season infestations. In table grapes, defoliation of the top of the vine can result in sunburned, discolored fruit (Jensen and Flaherty 1981b).

Aphids. Damage to grapes occurred in the 1950s on an occasional basis. The species was not determined. At this time no economic damage is attributed to aphids (Jensen and Kido 1981).

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Aphids. Several species of aphids are potential problems on strawberries. Direct damage is caused by the removal of plant juices during feeding. When present in large numbers they weaken the plants. The large amounts of honeydew excreted during feeding supports the growth of sooty mold. When this occurs on the fruit, quality is lost. The major problem with aphids on strawberries is their role in transmitting virus diseases to the plants. When aphids are not controlled and virus sources are nearby, nearly 100% infection can occur in as little as two weeks but generally occurs within two or three years (Mass 1984).

Spider mites. Mites remove the contents of strawberry leaf cells during feeding. This results in dry areas in the leaves and when populations are very high may result in stunting and die back of the plants. This can affect the current year's crop and significantly reduce the following year's yield. Plant death may occur when damage is combined with drought stress (Goulart et al. 1988, Mass 1984).

Strawberry leafrollers. Damage to strawberry is caused by larval feeding on the foliage. Continuous feeding causes leaves to turn brown and die. One species, the omnivorous leaf tier, is a pest in California. A high proportion of the larvae feed on the berries and may remain inside. Even low populations cause serious damage by contaminating the processed fruit (Mass 1984).

Lygus bugs. Adults suck sap from strawberry buds, blossoms, newly formed green fruits, and tender growing leaf tips. While feeding a toxic saliva is injected into the plant tissue. When young fruit are attacked the toxic saliva kills some of the tissue causing the berry to develop unevenly. This produces a fruit with a knobby button-like appearance (Goulart et al. 1988, Mass 1984).

Apples/Peaches/Pears/Plums

Controls are recommended primarily during the early part of the season for leafrollers, fruitworms, aphids, Lygus bugs, and codling moth. Exceptions are for mites and obliquebanded leafrollers which often require treatment during the middle of the season. Numerous sampling schedules and treatment thresholds are suggested. The treatment thresholds vary, depending on the pest and the time of year. Rosy apple aphids are scouted for at pink-bud. New York recommends treatment if 5% of the leaves in fruit clusters have rosy apple aphids (Agnello et al. 1988) while North Carolina suggests a threshold of 10% of the terminals infested after Second Cover Spray (Walgenbach 1988). The threshold for apple aphid is 50% of the terminals infested in North Carolina (Walgenbach 1988).

All states surveyed recommend a pesticide application at petal fall to reduce insect pest populations. Thresholds for leafrollers are 3% of the leaf clusters infested during bloom in New York (Agnello et al. 1988) and five larvae or fresh feeding scars observed on 300 fruit in every 10 acres (Walgenbach 1988). In New York, if the threshold during bloom is reached, the petal fall insecticide must be selected to provide control of leafrollers

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as well as the other targeted pests. In early July, the New York threshold is 12% of the leaf and fruit clusters infested (Agnello et al. 1988).

New York uses a variable threshold for mites depending on the time of year. Through June 15 the threshold is 2.5 mites/leaf; June 16-30, 5 mites/leaf; July 1-15, 7.5 mites/leaf; July 16 - August 1, 10 mites/leaf (Agnello et al. 1988). North Carolina used a threshold of 85% of the leaves infested with one or more mites (Walgenbach 1988).

Other pests such as Lygus bugs and codling moth are generally controlled with the petal fall and first cover sprays recommended by nearly all apple producing states. Codling moth can be sampled with pheromone traps. North Carolina uses a threshold of four moths caught each week for two consecutive weeks if one trap/3 acres is used or ten moths caught each week for two consecutive weeks if there is one trap/10 acres (Walgenbach 1988).

In general, mevinphos was used on only 5.7% of the acreage in the three states reporting its use on apples. The alternatives to mevinphos, rates, and number of acres to be treated are given in Table 4. In all three states, single applications would be used for all alternatives except chlorpyrifos which would require 1.5 applications on the average.

Both Illinois and New Jersey did not feel that there was a need for mevinphos or that there was any yield or quality reduction due to the use of the alternatives. The only advantage of mevinphos was that it could be used close to harvest. The alternatives were all safer to use.

New York felt that the alternatives were less hazardous, however all had longer preharvest intervals, were more expensive and with the possible exception of methomyl were less effective against the leafroller complex. Also, leafrollers are becoming more tolerant to the alternatives. Loss of mevinphos would increase losses due to leafrollers by 1-2% in years of heavy leafroller populations. For the three states using mevinphos on apples there is no economic gain from its use.

There were no reported uses of mevinphos on peaches, pears or plums.

<u>Cherries</u>

There were no reported uses of mevinphos on cherries.

<u>Citrus: Oranges/lemons/grapefruit</u>

There were no reported uses of mevinphos on citrus.

<u>Grapes</u>

California, the only state reporting use of mevinphos on grapes, treats 1.7 percent of its grape acreage with mevinphos annually. This indicates

that the alternatives to mevinphos, listed in Table 5, are the primary pesticides used for arthropod management.

Treatment thresholds for Grape Leafhopper vary with the grape variety, its end use, and the time of year. The following is an example using Thompson Seedless (Jensen and Flaherty 1981a):

Use	1st Brood	2nd Brood
raisins wine	20 nymphs per leaf	10 - 15 nymphs/leaf (Do not permit >20% leafloss) or 600 nymphal days from beginning of 2nd brood until harvest
Table grapes	10 - 15 nymphs/leaf	Early varieties: 10 nymphs/leaf Midseason varieties: 5 - 10 nymphs/leaf Late varieties: 5 - 8 nymphs/leaf or 300 nymphal days from beginning of the second brood until harvest

The need for treating mites depends on the vigor of the vineyard, the soil type and the species of mite present. Average to strong vineyards can tolerate fairly heavy populations. Poor soils result in weaker vines. Dusty conditions promote outbreaks of Pacific spider mites. Spot infestations require treatment only when beneficials are absent. General infestations with moderate or heavy Pacific mite populations and very few predators require immediate treatment. Low mite populations with few predators indicate delayed treatment. Moderate to heavy mite populations with predaceous mites frequent to numerous should be monitored (Flaherty et al. 1981).

Grape leaffolder management is not well defined. Vineyards should be monitored for young larvae and for leaf rolling. Wine and raisin grapes can withstand more defoliation than table grapes. The first brood rarely requires treatment. Second and third broods should be treated as the bulk of the brood begins to make new leaf rolls (Jensen and Flaherty 1981b).

Aphids are not a problem at this time in California vineyards. Controls

[illegible] used or orchard management

[illegible] thresholds for Grape leafhopper vary [illegible] the time of year [illegible] following is [illegible] ties (Jensen and Flaherty [illegible])

raisins	20 nymphs	0 - 15 nymphs
wine	per leaf	[illegible]
Table	[illegible] 15	[illegible]
grapes	nymphs/leaf	[illegible]
		Late [illegible]
		[illegible]

treating mites depends on the [illegible] the species of mite present. [illegible]

y heavy populations. [illegible] weak vines [illegible] more outbreaks of Pacific spider mites. [illegible] treatment only when beneficials are absent. [illegible] ate heavy Pacific mite populations and [illegible] mite treatment. [illegible] mite populations with few predators [illegible] treatment. Moderate to heavy mite [illegible] ites [illegible] to numerous should be monitored [illegible]

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Table 4. Use of Mevinphos on Apples (average annual), 1982-1986.

State	Acres Treated	Pests	Rate (lbs. a.i./A)	No. Appl.	Alternatives	Rate lbs. a.i./A (No. A treated)	Limitations
Illinois	1491	leafrollers	0.2	1.5	azinphosmethyl	0.625 (795)	longer PHI
		mites			phosmet	0.625 (693)	
		codling moth					
New Jersey	37	leafrollers	0.75	1-2	dimethoate	1.5	
		mites			methomyl	0.34	
		aphids			endosulfan	1.5	
		Lygus bugs					
New York	3212	leafrollers	1.0	1	chlorpyrifos	1.5 (642)	longer PHI
		fruitworms			endosulfan	2 (160)	(all alternatives)
					fenvalerate	0.2 (482)	more expensive
					methomyl	0.9 (1124)	less effective
					methyl parathion	1 (642)	against
					(Penncap-M)		leafrollers
					permethrin	0.4 (160)	

Table 5. Use of Mevinphos on Grapes (average annual), 1982-1986.

State	Acres Treated	Pests	Rate (lbs. a.i./A)	No. Appl.	Alternatives	Limitations
California	11,504	grape leafhopper	0.25-0.5	1-2	carbaryl parathion endosulfan methomyl dimethoate	disruptive to mite predators (except parathion and endosulfan)
		mites			dicofol propargite	
		grape leaffolder			carbaryl	disruptive to mite predators
					Bt parathion	

are not warranted or recommended.

Mevinphos is very disruptive to the beneficial predators that aids in control of mites, and leafhoppers. Several of the alternatives used to control leafhoppers and leaffolders are also disruptive to the mite predators. Bacillus thuringiensis, parathion, endosulfan, dicofol and propargite are considered relatively easy on the mite predators.

The primary advantage of mevinphos is that it can be used close to harvest for late season pest outbreaks. A 6% yield benefit is realized when mevinphos is used. However, the costs of the alternatives are $8.38/acre less. In the aggregate, however, there is negative economic benefit to the use of mevinphos.

Raspberries

There were no reported uses of mevinphos on raspberries.

Strawberries

Use of mevinphos on strawberries was heavier than use on apples and grapes. Florida apparently relies completely on mevinphos for arthropod management. California treats 22.5% of its crop with mevinphos while New Jersey treats only 2.8% of its crop with mevinphos.

Alternatives listed by New Jersey include azinphosmethyl, parathion, carbaryl and endosulfan for aphids; dicofol and oxydemeton-methyl for mites; and diazinon, azinphosmethyl and carbaryl for leafrollers. Each would be used once a year. Rates and acreages treated with alternatives are given in Table 6.

All of the alternatives have longer preharvest intervals but are safer to use. New Jersey did not have any yield benefit from the use of mevinphos while California experienced a 60% yield benefit and Florida a 15% yield benefit. Control costs were $152.99/acre more for the alternatives in California, $67.74/acre less for the alternatives in Florida, and the same in New Jersey.

In summary, mevinphos appears to be needed for strawberry production.

Walnuts

There were no reported uses of mevinphos on walnuts.

Table 6. Use of Mevinphos on Strawberries (average annual), 1982-1986.

State	Acres Treated	Pests	Rate (lbs. a.i./A)	No. Appl.	Alternatives	Rate lbs. a.i./A (No. A treated)	Limitations
California	3002		0.25-0.5	3			
Florida	5160		1.0	14-21			
New Jersey	17	aphids	0.5	1	azinphosmethyl	0.5 (1.7)	longer PHI (all alternatives)
					ethyl parathion	0.5 (0.9)	
					carbaryl	1.0 (13)	
					endosulfan	0.99 (1.7)	
		mites			dicofol	0.7	
					oxydemeton-methyl	0.75	
		leafrollers			diazinon	0.5 (7)	
					azinphosmethyl	0.5 (7)	
					carbaryl	1.0 (8.5)	

FIELD CROPS

Alfalfa for Hay

Mevinphos (Phosdrin 4EC or Phosdrin IPA4) may be applied to alfalfa for control of aphids and alfalfa caterpillar at a rate of 1/4 to 1/2 pint per acre; for control of grasshoppers, leafhoppers, cutworms (climbing), mites, alfalfa weevil larvae, and Lygus bugs use 1/2 to 1 pint per acre. Do not treat within two days of harvest. It can be used in conventional hydraulic sprayers, low-volume ground applicators, or airplane sprayers.

Alfalfa grown for hay is regularly subject to economic injury caused by several of the insects for which mevinphos is registered, such as alfalfa weevil larvae, leafhoppers, and aphids. Others, such as the alfalfa caterpillar, grasshoppers, and cutworms occasionally cause damage. Losses ranging up to 100% for a given cutting have been observed, although losses are usually much less. Losses from the alfalfa weevil and from leafhoppers are generally restricted to only one or two harvests per year. In some areas hymenopterous parasites and a fungal disease have reduced the alfalfa weevil to sporadic pest status.

Most recommendations combine thresholds for either chemical application or early harvest, with resistant cultivars for spotted alfalfa aphid or winter harvest and parasite conservation for the alfalfa weevil. There are a number of insecticides available.

Only four states reported using mevinphos on alfalfa for hay (Table 7). Based upon their reports, ca. 54,200 acres of alfalfa are treated, this constitutes ca 0.2% of the average 26,078,000 acres of alfalfa harvested for hay 1986-88 (Va. Agr. Stat. Serv. 1988). In the two states which reported the acreage of alfalfa grown in their states, the per cent of the crop treated with mevinphos was <1% in Pennsylvania, and <0.1% in Nevada. There is obvious variation in use from year to year depending on the pest densities. There is usually only one treatment per year except in Nevada where there are usually two. The rate of application of mevinphos varies from 0.125 to 0.5 pounds actual per acre.

Mevinphos is most likely to be applied to alfalfa for hay either just prior to harvest to avoid late pest injury, or when there are flowering weeds in the field which are being visited by bees when controls must be applied to control a serious pest. A late evening treatment with a short residual insecticide such as mevinphos could reduce pest injury without killing many bees (similar to the situation on alfalfa grown for seed). However, on alfalfa grown for hay, neither situation is necessary. Advancing the harvest date is almost always preferable to application of a spray just before harvest. Regarding the second situation, weeds in alfalfa should be controlled as in any other crop. If weeds are present, and a spray is necessary, the beekeeper should be notified to move or protect his bees. Bees may also be attracted to the honeydew produced by the blue alfalfa aphid or the spotted alfalfa aphid.

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Table 7. Use of Mevinphos on Alfalfa for Hay (average annual), 1982-1986.

State	Acres Treated	Pests	Alternatives	Rate (lbs a.i/A)	Applic. Method	Limitations[2]
Calif.	45267 est.	Aphids Loopers Armyworm Cutworm G-hoppers Mites	MSR[1] trichlorfon	.25-.5	Gr & Air	MSR- 2/day PHI Trichlorfon- acceptable substitute
Nevada	225	Aphids Lygus Alf.Weev. G-hoppers		.125-.5	Gr & Air	MSR- 2/day PHI Trichlorfon- acceptable substitute
Oregon	725	Aphids		.25-.5	Gr & Air	MSR- 2/day PHI Trichlorfon- acceptable substitute
Penn	8000 est.	Alf.Weev.	methomyl carbofuran chlorpyrifos dimethoate malathion azinphosmethyl methoxychlor	.25-.5	Gr & Air	Malathion- less effective others >2 days PHI

[1]MSR = Meta-Systox R, oxydemetonmethyl

[2]PHI = Preharvest interval

The reports by Stoltz and Baird (1986) and Peairs (1986) show that we now have a number of insecticides which are not only more effective than mevinphos, but have a lower mammalian toxicity. Their data also cast doubt on the idea that mevinphos residues disappear very quickly in the field, the control shown by their 3 day counts for aphids and 7 day counts for webworms in the mevinphos (Phosdrin) treatments were not markedly different from earlier counts.

Mevinphos is applied both by ground and airplane applicators. Thus, there may be spray drift onto nearby crops or noncrop areas. This represents a real danger to man, domestic animals, and wildlife which are present during or shortly after an application. The short residual effect of mevinphos reduces the hazard to individuals or animals which enter an area a day or two after it has been treated, as well as reducing concerns over toxic residues on nontarget areas.

The insecticides which have been suggested as alternatives by our survey form respondents (Table 8), are all less toxic and have a greater residual longevity than mevinphos. The alternatives are quite variable in their toxicity. We do not have information regarding their effectiveness under various field conditions and for individual pest species.

Alfalfa-seed production

Mevinphos is used in alfalfa seed production to control aphids, alfalfa caterpillar, grasshoppers, leafhoppers, cutworms (climbing), mites, alfalfa weevil larvae, and Lygus bugs. Rates for the first two cited pests vary from 0.125-0.25 lb a.i. in 10-125 gal. water/acre. For other cited pests, registered rates range from 0.25-0.50 lb a.i. in 10-125 gal. water/acre. See Table 9.

A major benefit of mevinphos stems from its short pre-harvest interval (PHI) of 2 days. Major hazards include toxicity to non-target organisms, pollinators, beneficial insects, and high user (man) toxicity. (See below).

Production of alfalfa seed is a highly specialized and management intensive process. Management components include three primary facets: 1) control of detrimental insects; 2) the supply of effective pollinators (various species of bees); and 3) irrigation water at time of bloom.

The short residual organophosphates, oxydemeton-methyl, naled, mevinphos and trichlorfon are presently the cornerstones of the insecticide component of pest control - especially in the Pacific Northwest production areas. These chemicals (and mevinphos in particular) provide short residual control of primary and certain secondary pests during the flowering period when pollinators are active. University and industry personnel who deal with this important commodity feel that the loss of these short-residual chemicals would devastate alfalfa pest management systems and would result in seed fields receiving 8-10 applications of other insecticides per year.

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Table 8. A Comparison of Toxicities Between Mevinphos and Other Insecticides Recommended as Alternatives on Alfalfa for Hay.

Insecticide	Rat acute oral LD_{50}	Rat acute dermal LD_{50}
Mevinphos	3-7	3-90
Azinphosmethyl	11-16	220
Carbofuran	8-14	>10200 (Rb)[1]
Chlorpyrifos	82-245	202
Dimethoate	28-500	>150-<1150
Malathion	885-2800	4000->4444
Methomyl	17-24	>5000 (Rb)[1]
Methoxychlor	5000-7000	>2820->6000
Naled	250-430	800
Oxydemetonmethyl	47-75	100-250
Trichlorfon	450-630	>2000

[1]Acute dermal toxicity for rabbits.

Data from: Larson, L. L., E. E. Kenaga and R. W. Morgan. 1985. Commercial and experimental organic insecticides. Entomol. Soc. Amer. 105 p.

Table 9. Use of Mevinphos on Alfalfa for Seed (average annual), 1982-1986.

State	Acres Treated	Pests	Alternatives	Rate (lbs. a.i./A)	Applic. method	Limitations[3/]
Oregon plus Idaho	2,500	aphids[1/] *Lygus*[2/]	dimethoate oxydemeton-methyl trichlorfon parathion malathion diazinon carbofuran	.125-.50	ground or air	Trichlorfon-acceptable substitute malathion-less effective others >2 days PHI
Nevada	1,037	aphids *Lygus*	same as for Oregon	.25-.50	ground	Trichlorfon-acceptable substitute malathion-less effective others >2 days PHI
Washington	6,000	aphids *Lygus*	same as for Oregon	.25-.50	ground or air	Trichlorfon-acceptable substitute malathion-less effective others >2 days PHI

1/ 3 aphid spp. - pea aphid, alfalfa aphid and blue aphid
2/ *Lygus* spp. *L. elisus* and *L. hesperus*
3/ PHI = Preharvest interval

The primary pest for which mevinphos is applied is late season Lygus bug control - a primary seed pest. Users report good control of grasshoppers, control of alfalfa weevil, and some use to suppress seed chalcid. Mevinphos has very severe impact on some beneficials and has a high applicator hazard, but is relatively safe on pollinating bees with only a 5-hr or less residual activity. With timing of mevinphos applications after sunset, the hazard to bees is minimized.

A synopsis of on-farm usage of mevinphos is supplied in Table 9 for states reporting. A noticeable gap is the lack of specific use reports from California.

Mevinphos usage ranges from 0%-70% of commodity area treated, with Nevada reporting the highest percent usage. Few data are available concerning seasonal and regional variability in the use of mevinphos. In general, mevinphos was not recommended for major uses on a very large percentage of commodity areas. Mevinphos has been used in 1988 in Nevada and may be recommended in isolated cases in 1989. The frequency of application for mevinphos ranged from 1.0-4.0 within a single season, with the lower figure predominant. Only Oregon reported more than 2.5 applications in a single season. Where more than one application of mevinphos is applied, the interval is 2 or more weeks. The median for active ingredient applied per acre was 0.375 lb. In 1988, all applications were at this rate, while in earlier years the range was 0.25-1.0 lb/acre.

The usage of mevinphos for alfalfa seed production was concentrated on late season Lygus bug control. Some usage during flowering stages is common because of the short residual and minimum impact on pollinating bees.

In most northwest production areas, alfalfa seed producers apply insecticides with field sprayers pulled by closed-cab tractors. In the Columbia Basin of Washington, the insecticide is applied by aircraft. The preference for ground application stems from the better performance (% kill) when sprayed 2-3 feet over the canopy with high gallons per acre.

In agroecosystems in California, mevinphos is used only occasionally as a pre-harvest treatment after honey-bee hives are removed from fields. There the crop rotation and pest complex differ because of the proximity of alfalfa seed cropping with cotton and safflower. There honeybees are relied upon to pollinate seed fields, whereas in the major seed producing areas in the Northwest, the wild bees (alkali bee and leafcutting bee) are depended upon almost exclusively for pollination. Honeybees differ from the wild bees with respect to insecticide tolerance and, where appropriate, mevinphos is used in Fresno and Kin Counties because of its efficacy and low hazard to bees. Overall, the extremely short residual of mevinphos does not affect cropping rotation or re-use of land.

The production of alfalfa seed is closely tied to integrated pest management systems developed in Oregon, Idaho, Nevada and the San Joaquin Valley area of California. The classic components of alfalfa seed IPM are: 1) weekly sampling to monitor pest and beneficial insect populations, 2) use of research-derived economic thresholds, 3) conservation of beneficials and

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4) selective use of pesticides. Mevinphos plays an important role in 4 (above) because of its safety to pollinating bees when applied after sunset, and its short residual, and hence, short pre-harvest interval of one day. Additionally, mevinphos is highly effective for Lygus bug control.

All pesticides which are highly efficacious and destroy high percentages of the target population exert high selective pressures and consequent opportunity for build-up of pest resistance. Mevinphos is used only sparingly in most areas, and with the exception of Nevada, is restricted to a small percentage of commodity land area. The short residual on plant surfaces is a benefit in that immigrating insects are not affected, allowing in-flow of non-treated gene material. Overall, in alfalfa seed production, the potential for pest resistance to mevinphos is low. However, some Lygus resistance has been observed in California where insecticide treatments to the larger agroecosystems encourages area-wide resistance and cross-resistance especially to the older organophosphates that have been used extensively in California for many years.

Despite a highly evolved IPM for alfalfa seed production, pesticides occupy a key place in control of primary and secondary pests. The alternatives to mevinphos, presently, are four other pesticides under special review: carbofuran, oxydemeton-methyl (ODM), naled, and trichlorfon. Each has unique properties which impact the selectivity needed to control specific pests at specific times in the growth and harvest of alfalfa seed. The comparative efficacy or economic value of these insecticides cannot be evaluated in a vacuum, one against another, for a single pest species. Rather, their value must be judged in the context of a complex insect pest-pollinator management system with its subtle overlay of environmental factors. Table 10 modified from the Pacific Northwest producer's group report "Biological and economic assessment of ODM, trichlorfon, naled, and mevinphos in alfalfa seed production" compares alternative insecticides for use in the flowering-pollinating period critical to production of seed.

Field Corn

Constraints to corn production in the United States include a multitude of insect pests which may affect corn from planting to maturity. Management of the more important insect pests requires planned cultural and insecticide programs that reduce real or potential damage throughout the production season. The extent of insect management efforts in corn should be, and is, largely to prevent yield reduction. In most areas of the U.S. where insecticides are used in management programs, some degree of insecticide persistence is required. This is particularly true in the major corn-growing region of the Midwest. In fringe areas or areas where corn may be grown for special purposes, unique insect problems often occur. In these areas, insecticide requirements may also be unique.

Only two states, Colorado and Florida, responded to field corn production questions on a survey to determine mevinphos use and need in the U.S. Within these two states, an average of 820 acres was treated annually with mevinphos from 1982 through 1986 (Table 11). In Colorado, mevinphos was

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is a benefit [illegible] that [illegible]
f non-treated gene [illegible]
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has been observed [illegible] Califi[illegible]
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e especially in the older [illegible]
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ly to mevinphos [illegible]
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ir value must be judged in [illegible]
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Table 10 modified from the Pacific [illegible]
biological and economic assessment [illegible]
in alfalfa seed production [illegible]
overing-pollinating period [illegible]

[illegible] s to corn production in the United States [illegible]
pests which may affect corn from planting [illegible]
important insect pests requires [illegible]
to reduce real or potential damage [illegible]
extent of insect management programs in corn [illegible]
prevent yield reduction. In most areas of the U.S. [illegible]
are used in management programs, [illegible]
is required. This is particularly true in the [illegible]
Midwest. [illegible] large areas or areas where corn [illegible]
unique [illegible] problems often occur. In these areas,
me[illegible]ts may also be unique.

[illegible] responded as field corn
[illegible] use and need in the
[illegible] was treated annually
[illegible] orado, [illegible]

Table 10. Effectiveness of Insecticide Use on Alfalfa in the Northwest During Flowering-Pollination Period.

Chemical	Rates (lbs. a.i./A)	Effect on 1° Pest *Lygus* bugs	Effect on 2° Pests	Impact on Beneficials	Other Advantages or Disadvantages
Oxydemeton methyl (ODM)	0.375-0.5	Excellent on early season Lygus, good to fair on late season Lygus.	Good on pea aphid Some mite suppression	Moderate	Systemic action, Relatively bee safe.
Naled	0.5-1.0	Very good on late season Lygus	Good on grasshopper, Fair on Lepidoptera	Severe	High bee risk, weather conditions need to be carefully monitored when applying.
Mevinphos	0.25-0.5	Very good on late season Lygus	Good on grasshopper Fair on alfalfa weevil. Some use to suppress Chalcid.	Very Severe	Relatively safe on bees. High application hazard.
Trichlorfon	0.5-1.0	Poor on Lygus except in Montana and other select areas.	Very good on small Lepidoptera	Moderate	Relatively bee safe. Resistance problem with Lygus.
Permethrin	0.1-0.2	Inconsistent on Lygus	Inconsistent on aphids	Very Severe	Mite outbreak following treatment. Seed specialists recommend against use because of high risk of bee kills.

Table 11. Use of Mevinphos on field corn for grain and forage (average annual), 1982-1986.

State	Acres Treated	Pests	Alternatives	Rate (lbs. a.i./A)	Applic Method	Limitations[1]
			Corn - Grain			
Colorado	320	Fall Armyworm Earworm	permethrin	0.10	Air	1 day
			chlorpyrifos	0.50	Air	30 days
			fenvalerate	0.10	Air	21 days
			trichlorfon	0.50	Air	1 day
			Corn - Forage			
Florida	500	Aphids	Parathion (ethyl)	.20	Ground	1 day
			Parathion (methyl)	1.00	Ground	1 day

[1]Pre Harvest Interval

applied to control earworm [Heliothis zea (Boddie)] and fall armyworm [Spodoptera frugiperda (Smith)]. In Florida, mevinphos was used to obtain control of corn leaf aphid [Rhopalosiphum maidis (Fitch)] in the same application with another insecticide or fungicide.

Insect biology is an important factor when considering pest management. In the mevinphos use survey, corn earworm and fall armyworm were the most important field corn pests reported from Colorado, and corn leaf aphid was the most important pest reported from Florida.

The corn earworm, Heliothis zea (Boddie), and fall armyworm, Spodoptera frugiperda (Smith), overwinter as pupae (in southern latitudes of the U.S. and in South and Central America, fall armyworm may overwinter in all stages). Adults emerging from overwintering stages lay eggs on wild and cultivated hosts during the early season. Following egg, larval and pupal development, moths from this first and subsequent generations migrate to more northern regions. In these northern regions, corn is the preferred host.

Damage by corn earworm results from larval feeding in the whorls of immature plants and on silks and kernels of developing ears during and following pollination. Injury appears in the form of ragged leaves in the whorl and overall reduced plant vigor. This damage may result in delayed silking, poor pollination and yield loss for plants severely affected. Direct losses of 2 to 4% per developing ear may result from larval feeding in the silk channel and on developing kernels (Blanchard and Douglas, 1953; USDA Handbook, 1965).

Fall armyworm damage to corn usually occurs in Colorado during the same time period or slightly later than for corn earworm damage. Fall armyworm damage usually results from whorl and ear feeding by developing larvae.

Fall armyworm is found throughout the year in South America, Central America, and the southeastern U.S. But each year it migrates northward, arriving in the central U.S. and Colorado in late June to late July. After arrival, fall armyworm usually undergoes two generations. The first generation adults oviposit on leaves, and emerging larvae feed on leaves in the unfolding whorl and on developing ears. The fall armyworm life cycle is most frequently synchronized with the appearance of the silks during the pollination period. Developing larvae then feed primarily on the ear. Damage to the ear is often similar to that of earworm. However, unlike earworm, this species feeds on and into the basal portion of the ear. This type of damage is usually the most destructive, and under heavy infestation levels can result in severe yield losses. Fortunately, damage by this insect is less frequent than for corn earworm.

Colorado growers elected to treat approximately less than 1% annually of planted corn acres (660,000) with mevinphos during 1982-86 for either (or both) corn earworm and fall armyworm to avoid perceived and real potential yield reduction. Mevinphos was reported as having no distinct advantages for corn earworm and fall armyworm control over the four alternative insecticides listed in Table 11.

... earworm [illegible] zea (Boddie) [illegible] armyworm
... frugiperda (J. E. Smith) ... Heliothis, respectively ... [illegible]
... leaf aphid (Rhopalosiphum maidis (Fitch)) ... [illegible]
... another insect ... [illegible]

... ology is an important factor ... [illegible]
... 05 use survey ... earworm and fall armyworm ... [illegible]
... ld corn pests ... from Colorado, and corn leaf aphid
... major pest reported from Florida.

... earworm, Heliothis zea (Boddie) and fall armyworm
... frugiperda (J. E. Smith), ... overwinter ... southern ... [illegible]
... South and Central America. Fall armyworm ... overwintering
... emerging from overwintering ... eggs ... on ... [illegible]
... during the early season. ... larval ... [illegible]
... from this first and subsequent ... generations migrate ... [illegible]
... In these northern regions, corn is ... preferred ... [illegible]

... corn earworm results from larval feeding ... [illegible]
... ants and on silks and kernels of developing ears. ... [illegible]
... pollination. Injury appears ... [illegible]
... all ... plant vigor. This damage may ... [illegible]
... pollination and yield loss ... plants ... [illegible]
... as ... to 4% per developing ear may result from larval feeding ...
... and on developing kernels (Blanche ... [illegible]

... worm damage to corn usually ... [illegible]
... slightly later than for corn earworm ... [illegible]
... results from whorl and ear feeding by ... [illegible]

... worm is found throughout the year in South America ... [illegible]
... the southeastern U.S., but ... [illegible]
... central U.S. and Colorado in late ... [illegible]
... fall armyworm usually ... [illegible]
... adults ... on leaves, and emerging larvae ... [illegible]
... whorl and on developing ears. The fall armyworm ... [illegible]
... usually synchronized with the appearance of the silks ... [illegible]
... period. Developing larvae then feed primarily on the ... [illegible]
... the ear is often similar to that of earworm. ... [illegible]
... is spec... on and into the basal portion ... [illegible]
... age is usually the most destructive ... [illegible]
... result in severe yield losses. Fortunately, damage ... [illegible]
... went than for corn earworm.

... growers elected to treat approximately less than ... [illegible]
... acres (650,000) with ... during 1987 ... [illegible]
... and fall armyworm in ... and treat ... [illegible]
... was reported as having no ... [illegible]
... worm control over the four alternative ... [illegible]

The corn leaf aphid, Rhopalosiphum maidis (Fitch), was identified by Florida entomologists as the most important aphid pest of corn used for forage. In the warmer climates of the U.S. (including California, Florida and Texas), aphids can reproduce throughout the year and multiply rapidly under favorable conditions. Corn leaf aphids feed on tassels and silks and coat them with honeydew, which results in reduced pollination. Severely infested tassels may become depleted of moisture and drop from the plant. Thus, overall vigor of the plant may be affected. Corn leaf aphid is also noted for transmission of pathogenic viruses (including maize dwarf mosaic) which adversely affect plant growth, yield and quality of grain and forage.

Mevinphos applied for control of aphids (all species) was approximately 1% or 500 of 46,200 acres per year during 1982-86. This insecticide apparently offers no distinct advantage over alternatives ethyl and methyl parathion (Table 11). Mevinphos is slightly more effective for aphid control, and only one application is needed to obtain control. This application is often made in conjunction with other insecticides or fungicides.

In Colorado, corn is grown in sandy soil regions where irrigation is available and provides an economical return on investment. Corn is followed by corn in production fields and is grown exclusively for grain. In these sandy soils, herbicides are not always effective for grass control and because of intensive irrigation and rapid corn growth, only one cultivation for weed control is possible. In some areas, cultivation may not be possible because of increased erosion potential.

Late planting, coupled with grassy weeds, attracts corn earworm and fall armyworm adults and provides an ideal mating and oviposition habitat. To prevent yield losses during years of heavy infestation by one or both pests, one application of an effective insecticide, mevinphos or alternatives (Table 11), is made during the late-whorl to full pollination stage.

Field corn produced in Florida is used primarily as forage for beef cattle production. Ear development is important for maximum yields and food value. Total yield is dependent on adequate rainfall, as well as proper fertility and agronomic practices. In Florida, the corn leaf aphid and other aphids are present every year and become important to corn production when populations peak during tassel emergence and silking. Pollination may be reduced or prevented.

Efforts to control aphids by one application of mevinphos or other short residual insecticide are usually made during years of adequate rainfall. During dry or unproductive seasons, profitable returns on insecticide investment for aphid control are usually not anticipated. Aphids are not controlled during such seasons and are made part of the forage if they are still present at time of ensilage chopping.

Extension entomologists in both Florida and Colorado reported no hazard to other crops, livestock or the surrounding environment.

In Florida, corn is grown in sparsely populated regions. Mevinphos or alternative parathion (Table 11) is applied only by experienced applicators.

[illegible] corn aphid, *Rhopalosiphum maidis* [illegible]
[illegible] the warmer climates of the U.S. [illegible]
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transmission of pathogens [illegible]
[illegible] affect plant growth [illegible]

[illegible] applied for control [illegible]
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offers no distinct advantage [illegible]
(Table [illegible]). Nevertheless [illegible]
application is needed [illegible]
in conjunction with other [illegible]

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and provides an economic [illegible]
production field [illegible] is grown [illegible]
herbicides are not always [illegible]
intensive [illegible] rapid [illegible]
[illegible] is possible. In some areas, [illegible]
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[illegible], coupled with grassy weeds, [illegible]
[illegible] provides an ideal [illegible]
[illegible] losses during years of heavy [illegible]
[illegible] of an effective insecticide [illegible]
[illegible] during the late whorl to full [illegible]

[illegible] corn produced in Florida is used primarily [illegible]
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present [illegible] year and become [illegible]
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prevented.

[illegible] control aphids by one application of [illegible]
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[illegible] and are made part of the [illegible]
[illegible] chopping.

[illegible] between [illegible] Florida and [illegible]
[illegible]

Corn production fields are usually rotated to one or more crops including soybeans, peanuts, tobacco and infrequently, vegetables. Corn is an essential crop to reduce nematode problems in these rotation schemes.

In Colorado, corn is produced in isolated sites away from populated areas. Aerial application is the choice method because of extremely low hazard potential.

Insecticide resistance in highly mobile species usually occurs only when insecticides with long residual activity are applied frequently at sub-lethal dosages over extensive regions. Corn earworm, fall armyworm and aphids are mobile, but mevinphos does not fit into the mode of resistance development. Because mevinphos is used only once per annum and has no residual activity, potential for development of resistance is negligible.

Insecticide controls remain an important method of managing insects. Where used prudently and judiciously, losses and environmental disruption are minimized. This is particularly true where insecticide use is necessary only once per season and residues are non-existent. Mevinphos and certain other organophosphate-type insecticides fit this description. The insects described previously may be sporadic in building to economic levels requiring an insecticide application. According to returned questionnaires, only one application of mevinphos or alternative compounds is required during the season. Alternative controls for corn earworm and fall armyworm in Colorado and aphids in Florida are limited (Table 11). Cultural control options are few and limited primarily to planting date. Early planting is weather dependent but is practiced when possible because the later the planting, the greater the infestation.

The insecticides listed as alternatives by Colorado for corn earworm and armyworm control include two organophosphates, trichlorfon and chlorpyrifos; and two synthetic pyrethroids, fenvalerate and permethrin. These alternative insecticides provide comparable control, are slightly less hazardous to the applicator and provide residual activity.

Fields are usually [illegible] ...nts, tobacco and [illegible] to reduce nematode [illegible]

...lorado, corn is produced in [illegible] ...ial application of the chemical [illegible] ...ntial.

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...icide controls remain [illegible] ...identify and judicious [illegible] This is particularly true when [illegible] ...ason and residues [illegible] ...ate-type insecticides [illegible] ...uciously may be superseded in [illegible] ...application. According [illegible] ...mevinphos or alternative [illegible] Alternative controls for [illegible] in Florida are limited (Table 11) [illegible] ...primarily to planting date. Early [illegible] ...ut is practiced when possible because [illegible] infestation.

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Sorghum for Grain and Forage

Insects pose a sorghum production constraint wherever it is grown in the United States. From planting through grain formation insects can influence yield. As a result management of the more important insects pests requires planned cultural and insecticide programs that reduce economic yield loss throughout the production season. In different geographic locations insecticide usage may be unique.

Florida and Colorado were the only two states that responded to a questionnaire to determine if mevinphos is indeed needed for sorghum production. In Colorado, between 1982 and 1986, mevinphos was applied annually to control greenbugs on an average of 640 acres: 320 acres for grain and 320 acres for forage. Similary in Florida, between 1982 and 1986, mevinphos was applied annually to an average of 450 acres of grain sorghum and 1250 acres of forage sorghum. Florida respondents did not state specifically what pest was treated.

In Colorado, aphids, corn earworms, fall armyworms, climbing cutworms and armyworms were listed as sorghum insect pests. In Florida, aphids, corn earworms, fall armyworms, and sorghum webworms were listed as sorghum insect pests. Also, both states recommend the use of mevinphos for controlling these insect pests.

Insect biology is an important factor when considering pest management. In the mevinphos survey the greenbug aphid and fall armyworm are the most important in Colorado. In Florida, aphids, corn earworms, fall armyworms and sorghum webworms have equal importance.

The greenbug, <u>Schizaphis</u> <u>graminum</u> (Rondani), is prolific and of general distribution and has great prolificacy. In some years, it has reduced sorghum production 25%. While feeding the aphid injects a toxic saliva which causes discoloration and tissue destruction. In the southern states this insect passes the winter in the active nymphal and adult stages and this is generally true in both Florida and Colorado. Economically, the decision to treat is based on the amount of damage to the plant at different stages of growth. Example: Emergence to six-inch, treat when plants begin to yellow and visible colonies are present on the leaf; Six-inch to pre-boot, treat when colonies cause red spotting or yellowing on leaves but prior to the death of any one leaf; Pre-boot to heading, treat before the death of one functional leaf; Heading to hard dough, treat when numbers are sufficient to kill two normal sized leaves.

The female aphid gives birth to living young which may become either winged or wingless. Each female begins reproduction between 7 and 18 days of age and continues to reproduce for 20 to 30 days giving birth to 50 to 60 offspring. The winged form can migrate to nearby plants, or for several hundred miles.

The corn leaf aphid, <u>Rhopalosiphum</u> <u>maidis</u>, was also identified by Florida entomologists as an important sorghum aphid. Again, this aphid can

reproduce throughout the year and multiply rapidly under favorable conditions. Corn leaf aphids feed on the underside of the leaf and in the whorl area as the sorghum head emerges. The feeding of this aphid can reduce plant vigor and/or reduce grain fill by feeding on the newly emerging head.

The corn earworm, Heliothis zea (Boddie), and fall armyworm, Spodoptera frugiperda (Smith), are both important pests of sorghum. The corn earworm over winters as a pupa in the southern latitudes of the United States. The fall armyworm may overwinter in all stages. Adults emerging from over wintering stages lay eggs on wild and cultivated hosts during the early season. Following egg, larval and pupal development, moths from first and subsequent generations migrate to more northern regions.

In Colorado both pests feed on foliage and heads. Generally they affect yield when they feed in the whorl and damage the growth bud, or when they feed on the head. In Colorado, they are considered economical if there are two or more larvae per head.

The sorghum webworm, Celama sorghiella (Riley), is also considered a major pest of sorghum in Florida. It is particularly damaging to the ripening kernels of grain in the sorghum heads.

In Colorado the insect pest problems occur within a time frame that will allow control with the alternative insecticides listed in Table 12, and still allow for the P.H.I. of the alternatives. However, according to survey results Florida entomologists, none of the alternatives listed in Table 12 will allow sorghum to be made into silage. This probably accounts for the 1,250 acres of mevinphos used on forage sorghum (1982-1986). Survey results from Florida respondents state that a 5-10% yield reduction would possibly occur without the use of mevinphos for forage sorghum.

Also, in Florida sorghum seed heads are vulnerable to the sorghum webworm and fall armyworm late in the season. As a result, a short P.H.I. is necessary some years. Carbaryl has a zero day P.H.I. and mevinphos has a three day P.H.I. for grain sorghum. Carbaryl does not provide as effective control for these pests, therefore the Florida entomologists feel that a 5% yield loss could result if Mevinphos were not available for use near harvest.

Florida entomologists reported no hazard to other crops, livestock or the surrounding environment. In Florida, sorghum is grown in sparsely populated regions. Mevinphos or most of the alternatives on Table 12 are applied by commercial applicators, so mevinphos doesn't present an unusual risk problem.

Currently in Florida, mevinphos is used on 5% of the forage sorghum acreage and 2.2% of the grain sorghum acreage annually. This accounts for a total of 1,700 acres. The remainder of the acreage is treated with the alternatives listed in Table 12.

The three day P.H.I. is probably the most important advantage of mevinphos regarding sorghum production plus the fact that it is the only insecticide registered for use on sorghum intended for silage.

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Table 12. Use of Mevinphos on Sorghum (average annual), 1982-1986.

State	Acres Treated	Pests	Registered Insecticides	Rates (lbs. a.i./A)	Limitations P.H.I.
SORGHUM FOR FORAGE					
Florida	1,250	Aphids	mevinphos	0.125 to 0.50	3 day
			dimethoate	0.4	28 day
			parathion	0.2	15 day
		Corn Earworm>	methomyl	0.4	14 day
		Fall Armyworm>	parathion	0.2	15 day
		Sorghum Webworm>	carbaryl	0.2	0 day
Colorado	320	Aphids	mevinphos	0.125 to 0.50	3 day
			chlorpyrifos	0.25	30 day
			dimethoate	0.25 to 0.50	28 day
		Armyworm>	methomyl	0.25 to 0.50	14 day
		Climbing Cutworm>	chlorpyrifos	0.50 to 1.00	30 day
		Corn Earworm>	mevinphos	0.25 to 0.50	3 day
		Fall Armyworm>	carbaryl	1.00 to 2.00	0 day
SORGHUM FOR GRAIN					
Florida	450	Aphids	mevinphos	0.125 to 0.50	3 day
			dimethoate	0.4	28 day
			parathion	0.2	15 day
		Corn Earworm>	mevinphos	0.125 to 0.50	3 day
		Fall Armyworm>	parathion	0.2	15 day
		Sorghum Webworm>	carbaryl	0.2	21 day
		Climbing Cutworm>	methomyl	0.4	14 day
Colorado	320	Aphids	dimethoate	0.25 to 0.50	28 day
			chlorpyrifos	0.25	30 day
			mevinphos	0.125 to 0.50	3 day
		Armyworm>	methomyl	0.25 to 0.50	14 day
		Climbing Cutworm>	chlorpyrifos	0.50 to 1.00	30 day
		Corn Earworm>	mevinphos	0.25 to 0.50	3 day
		Fall Armyworm>	carbaryl	1.00 to 2.00	21 day

VEGETABLE CROPS

Mevinphos is a vital pesticide to agricultural crops because of its wide spectrum-control of insects. It is especially important for vegetable crops because the short residual allows growers to control aphids and other insects close to harvest and allows them to market commodities without a loss.

Aphids are one of the most important pests controlled by mevinphos; they are economically important on most vegetable crops in all the states reported. Aphids are small, variously colored depending on species, and occur in clusters. At times, they are so dense that the entire plants may be covered if they are not controlled. When aphid populations reach high levels, they secrete honeydew, transmit diseases, cause young plants to lose vigor, decrease the maturation rate, and may kill the plant. If not controlled, heavy yield losses occur from contamination of the edible portion from honeydew, or as a result of diseases dissemination by aphids. In warm climates, aphids may remain active throughout the year, and some species give rise to living young all year. Most aphids are wingless when plants are young, but when plants harden-off or when populations expand and crowding occurs, winged forms are produced for migration.

Cabbage looper, a migratory lepidopteran, is a general foliage feeder on vegetable crops and is usually found in all regions where vegetables are produced. The destructive larva is light green with white or pale yellow stripes, has three pairs of prolegs, and moves with a characteristic looping motion. The adult white moth emerges in the spring and deposits dome-shaped, pale green eggs on host plants, mostly at night. After hatching, the larva reaches full development in 2-4 weeks. After 8-10 days in the pupal stage, new adults emerge. Three or more generations are produced each season.

Cabbage looper can be a severe pest to lettuce and cole crops. Loopers damage plants by eating ragged holes in leaves, boring into heads, and contaminating head and leaves with their bodies and frass. High populations can chew seedlings severely enough to kill or slow down the maturation of the crop. Heads contaminated with, or tunneled into, by loopers are not marketable.

Diamondback moth is a primary microlepidopterian pest of cole crops. In California and throughout the south, it is a year-round pest. The small yellowish-white eggs are laid singly, or less commonly in groups of two or three, on the undersides of leaves. The eggs are scalelike and very difficult to detect. In a few days the very small greenish larvae hatch and feed mostly on the underside of outer or older leaves of older plants, chewing small holes, or at the growing points of younger plants. Growing point injury causes the most serious losses. Damage to crowns of young plants can severely stunt growth. The larvae may also chew the growing points, or bore into developing heads of broccoli, cauliflower, and cabbage, causing serious damage or contamination (U.C., Pest Management Manual on Cole Crops, 1985). They become full grown in 10-14 days, depending on temperature, and then spin loose white cocoons, which they attach to leaves or stems.

VEGETABLE PESTS

[illegible] is a vital pesticide [illegible] agriculture [illegible]
[illegible] of insects. It [illegible]
[illegible] short residual actions [illegible]
[illegible] harvest and allows them to [illegible]

[illegible] one of the most [illegible]
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aphids are small, variously [illegible]
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[illegible] the maturation rate [illegible]
[illegible] yield losses [illegible]
[illegible] or as a result [illegible]
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crops and is usually found in all [illegible]
The destructive larva is light green [illegible]
three pairs of prolegs, and [illegible]
[illegible] adult white moth emerges [illegible]
eggs on host plants, mostly at night [illegible]
development in 2-6 weeks. After 8-10 days [illegible]
[illegible] Three or more generations [illegible]

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seedlings severely enough to kill or [illegible]
[illegible] contaminated with [illegible] or tunneling [illegible]

[illegible] is a primary microlepidopteran pest of cole crops [illegible]
[illegible] throughout the south. It is a year-round pest.
[illegible] eggs are laid singly, or less commonly in groups of two [illegible]
[illegible] undersides of leaves. The eggs are [illegible]
[illegible] In a few days the very small [illegible] larvae [illegible]
[illegible] the underside of outer or older leaves [illegible]
[illegible] holes, or at the growing points of younger plants [illegible]
[illegible] causes the most serious losses. Damage to [illegible]
[illegible] The larvae may also chew the [illegible]
[illegible] heads of broccoli, cauliflower, or cabbage [illegible]
[illegible] contaminants (U.C. Pest Management Manual on [illegible]
[illegible] full grown in 10-14 [illegible], depending on [illegible]
[illegible] loose white cocoons, which they attach to leaves

Adult moths are small and slender, grayish or brownish. When the moth is in its normal resting position, the wings of male moths display three diamond-shaped markings on their back that inspire the name "diamondback moth". The folded wings flare-up and out at the tip.

Imported cabbageworm is a widely distributed primary lepidopterian pest of cole crops. Adults are white to yellowish white butterflies with one to four black spots on their wings. They lay tiny white to yellow eggs, usually on undersides of the leaves. These hatch in seven or more days into velvety green, pubescent caterpillars, each having a narrow orange stripe dorsally and paler broken stripes laterally. Caterpillars are sluggish, but they eat voraciously. Young caterpillars chew holes in both the outer and inner leaves; older caterpillars move toward the center of the plant, often feeding at the base of the wrapper leaves or boring into the heads of cabbage, broccoli or cauliflower.

Imported cabbageworm damage is similar to that caused by cabbage looper. The caterpillars chew large, irregular holes in the leaves, bore into heads, and drop greenish brown fecal pellets which contaminate the marketable leaves and heads. Seedlings may be destroyed or crop maturity may be delayed with high populations. The most serious losses occur when the imported cabbageworm bores into the heads or feeds on marketable leaves.

Artichokes

Mevinphos is registered for use on artichoke for control of aphids at 0.125 lb ai/acre and artichoke plume moth at 0.25 lb ai/acre. Both uses have a two day preharvest interval. Artichoke production in the U.S. is predominantly in California where the sole use of mevinphos on artichoke is for plume moth control. Mevinphos has typically been applied once or twice per season to an average of 10,000 acres of artichokes.

The only alternative is azinphosmethyl, which is an unsatisfactory replacement for mevinphos because of its long (30-day) preharvest interval. Non-chemical controls do not give reliable insect control on artichokes. Mevinphos is needed for this crop.

Beans (Snap, Lima)

Mevinphos is used on snap bean acreage in some states for insect control close to harvest (Table 13). Arthropod pests controlled include aphids, leafhoppers, thrips, and mites. Five states reported usage of mevinphos on snap beans with the major advantage over alternative insecticides being the short pre-harvest interval. Other alternatives include dimethoate and acephate. The new synthetic pyrethroids labeled in recent years will control leafhoppers but not aphids, mites, or thrips. They have a longer post harvest interval (fenvalerate, 21 days), as do acephate and dimethoate (14 days).

Thrips control is an important use in North Carolina for mevinphos. It

Table 13. Use of Mevinphos on Beans (average annual), 1982-1986.

State	Acres treated	Pests	No. Appl.	Rate (lbs. a.i./A)	Alternatives	Limitations
Snap beans						
Tennessee	3500	aphids	2	1/4	acephate, dimethoate	longer PHI
Wisconsin	1000	potato leafhopper	1	1/4-1/2	acephate dimethoate fenvalerate	longer PHI
Arkansas	1500	mites	2	1/4-1/2	dimethoate	
Florida	2269	aphids mites leafhoppers	1	1/4-1/2	acephate methomyl dimethoate dicofol	longer PHI
North Carolina	2000	thrips	1	1/4	dimethoate methomyl	less control
					carbaryl	increases mites, kills bees
Lima beans						
Florida	23	aphids grasshoppers mites	2	1/4-1/2	methomyl acephate dimethoate	longer PHI

was preferred over dimethoate for that use and also preferred over carbaryl for caterpillar control (Table 13).

Beets

Mevinphos is registered for use on table beets for control of aphids, cabbage looper, climbing cutworm, dipterous leafminer adults, false chinch bug, grasshoppers, imported cabbage worm, leafhopper, mites and salt marsh caterpillar; it has a 3 day preharvest use restriction. Apparently the only significant use of mevinphos on table beets is for control of aphids and leafminers in Wisconsin. The principal advantage of mevinphos is its extremely short residual activity; however on table beets this is not of major importance since insect damage occurs on a portion of the crop which is not harvested. Diazinon, trithion and parathion are all viable alternatives to mevinphos for aphid and leafminer control on table beets.

Broccoli

Most of the commercial broccoli is grown in nine states with a total of 108,236 acres. Mevinphos is recommended in all nine states primarily to control aphids, cabbage looper, diamondback moth, and imported cabbageworm. Mevinphos was applied to broccoli at least one time in all nine states; in some states e.g., Alabama, it was applied 5 times. In California, there are several effective alternatives for control at early crop stages but growers must turn to mevinphos close to harvest because of its short preharvest interval. Other states (e.g. Alabama, Florida, Illinois, Louisiana, New Jersey, and Texas) have several effective alternatives registered to control the lepidopterous pest complex. However in Alabama, the diamondback moth develops resistance to the pyrethroids rapidly. Mevinphos in combination with Dipel has proven to give the most effective control. Controlling insects on broccoli is most critical during head formation, therefore a quick knock down short residual material such as mevinphos is necessary at maturity because it can be applied until 2 days before harvest (Table 14).

Cabbage

Fourteen states responded to the survey, representing a total of approximately 67,818 acres. Mevinphos is recommended in all the states with each reporting at least one application; the greatest number of applications, 3, was reported from Florida. The major target pests were aphids and diamondback moth.

Mevinphos plays an important role in 8 of the 14 states in controlling aphids and diamondback moth. Without mevinphos, marketable head loss varies from 3-5% in Wisconsin to as high as 80% in Florida due to contamination or feeding damage to the head. Pyrethroids are effective alternatives used in North Carolina and Wisconsin but are more expensive, and there exists potential resistance. In Alabama and Louisiana, mevinphos used alone against diamondback moth was not effective, however, used in combination with B.

[illegible] for [illegible] also [illegible] [illegible] control (Table [illegible]).

[illegible] registered for [illegible] beet [illegible] climbing cutworm, [illegible] imported cabbage worm, [illegible] it has a 3 day [illegible] use of mevinphos on [illegible] beets is [illegible] Wisconsin. The [illegible] activity [illegible] insect [illegible] Diazinon [illegible] for [illegible]

[illegible] the commercial [illegible] Mevinphos is recommended [illegible] cabbage looper, [illegible] was at 40% to broccoli [illegible] Alabama, [illegible] alternatives for cont[illegible] mevinphos close to harvest because of its short [illegible] states (e.g. Alabama, Florida, [illegible] have several effective alternatives [illegible] pest complex. However, [illegible] the pyrethroids rapidly [illegible] proven to give the most effective [illegible] control is most critical during [illegible] residual [illegible] applied until 2 days before harvest (Table [illegible]).

[illegible] responded to the survey, [illegible] acres. Mevinphos is [illegible] one application [illegible] Florida. The major [illegible] pests were aphids and [illegible]

[illegible] an important [illegible] of the [illegible] in [illegible] without mevinphos, [illegible] in [illegible] as [illegible] in Florida due to [illegible] are effective alternatives [illegible] expensive and [illegible] mevinphos used alone against [illegible] however, used in combination with [illegible]

Table 14. Use of Mevinphos on Broccoli (average annual), 1982-1986.

State	Acres Treated	Rate (lbs. a.i./A)	Alternatives: Chemicals	Rates (lbs. a.i./A)	Pests[1]	Limitations
Alabama[2]	300	0.5	<u>B. thuringiensis</u>			
			dipel/Javelin	Label	DBM	
			esfenvalerate	0.05	DBM	longer PHI
			fenvalerate	0.10	DBM	longer PHI
			permethrin	0.10	DBM	longer PHI
California[3]	40,372	0.25-0.5	permethrin	0.05-0.1	C,ICW,DBM	longer PHI
			diazinon	0.25-0.5	A,CL,ICW,DBM	longer PHI
			dimethoate	0.25-0.5	A	
			azinphosmethyl	0.5-0.75	DBM,CL,ICW	longer PHI
			methamidophos	0.5-1.0	A,DBM,CK,ICW	longer PHI
			oxydemeton-methyl	0.25-0.5	A	
			methomyl	0.9	A,DBM,CL,ICW	
			carbaryl		CL	
Florida[4]	71	0.25-0.5	methamidophos	1.0	A,CL,ICW	Toxic warm-blooded animals & beneficial
			ethyl parathion	0.2	A,CW,LB,M	
			endouslfan	1.0	A	resistance suspected, longer PHI
			permethrin	0.2	CL,LM,ICW	
			fenvalerate	0.1-0.2	CL,CW,GH,ICW	longer PHI
			flucythrinate	0.1	CL,SM	
			<u>B. thuringiensis</u>	Label	CL,SM	resistance suspected
			carbaryl	0.2-0.4	GH,SM,CW	
			ethyl parathion	0.2	LM	
			methyl parathion	1.0	LH	
			methomyl	0.5	ICW,SM	resistance suspected
Oregon	50% of acreage	0.25-0.5	oxydemeton-methyl		A,CL,ICW	longer PHI, poor control
			permethrin			
			methamidophos		A,CL,ICW	longer PHI, poor control
			methomyl		A,CL,ICW	longer PHI

Table 14 Continued

New Jersey	65	0.25	diazinon	0.5	A	longer PHI
			dimethoate	0.5	A	longer PHI
			disulfoton	1.0	A	longer PHI
			oxydemeton-methyl	0.5	A	longer PHI
			methamidophos	1.0	A,CL,ICW	longer PHI
			esfenvalerate	0.03	CL,ICW	longer PHI
			B. thuringiensis	Label	CL,ICW	
			azinphosmethyl	0.75	CL,ICW	longer PHI
			methomyl	0.9	CL,ICW	longer PHI
			flucythrinate	0.04	CL,ICW	longer PHI
			permethrin	0.2	CL,ICW	longer PHI
			fenvalerate	0.2	CL,ICW	longer PHI
Texas	50	0.25-0.5	acephate	0.5-1.0	A,LCX	
			azinphosmethyl	0.5-0.75	A,LCX	
			B. thuringiensis	Label	LCX	
			Diazinon	0.25-4.0	A,CW,LCX	
			endosulfan	0.75-1.0	A,LCX,CW	
			esfenvalerate	0.025-0.5	LCX,CW	
			fenvalerate	0.1-0.2	LCX,CW	
			malathion	0.625-1.25	A,LCX	
			methamidophos	0.5-1.0	A,LCX	
			methyl parathion	0.25-1.25	A,LCX,M	
			ethyl parathion	0.5	A,LCX	
			naled	2.0	LCX	
			permethrin	0.05-0.1	A,LCX	
			phosphamidon	0.5-1.0	A,LCX	
			carbaryl	2.0	CW	
			chlorpyrifos	0.5-1.0	CW	
			dimethoate	1.0	A	
			disulfoton	0.25-0.5	A,M	
			oxydemeton-methyl	0.375-0.75	A,M	

[1] A=aphids; CL=cabbage looper; CW=cutworm; DBM=diamondback moth; GH=grasshopper; ICW=Imported cabbageworm; LB=Lygus bug; LXC=caterpillar complex; LM=leafminers; M=mites; SM=saltmarsh caterpillar.

[2] 25% loss

[3] 15-20% loss

[4] 15% loss

Table 15. Use of Mevinphos on Cabbage (average annual), 1982-1986.

State	Acres Treated	Rate (lbs. a.i./A)	Alternatives			
			Chemicals	Rates (lbs. a.i./A)	Pests[1]	Limitations
Alabama[2]	100	0.5	esfenvalerate	0.05	DBM	longer PHI, resistant
			fenvalerate	0.1	DBM	longer PHI, resistant
			methomyl	0.45	DBM	
			permethrin	0.1	DBM	
			B. thuringiensis	Label	DBM	
California[3]	6,178	0.25-0.5	permethrin	0.05-0.1	DBM,CL,ICW	longer PHI
			diazinon	0.25-0.5	DBM,CL,ICW,A	
			dimethoate	0.25-0.5	A	
			azinphosmethyl	0.25-0.5	A,DBM,CL,ICW	
			methamidophos	0.5-1.0	A,DBM,CL,ICW	
			oxydemeton-methyl	0.25-0.75	A,DBM,CL,ICW	
			endosulfan	0.25-0.75	A,DBM,CL,ICW	
			methomyl	0.45-0.9	A,DBM,CL,ICW	
			trichlorfon	0.25-0.5	A,DBM,CL,ICW	
Florida[4]	10,461	0.25-0.5	methamidophos	1.0	A,CL,LM	longer PHI
			ethyl parathion	0.2-0.4	A,CW,LM,M,BL	
			endosulfan	1.0	A	
			permethrin	0.2	CL,ICW,LM	
			fenvalerate	0.2	CL,CW,ICW,GH	
			flucythrinate	0.1	CL,SM	
			B. thuringiensis	32 billion (Btu)	CL,SM	
			carbaryl	0.2-0.4	CW,GH,SM	
			methomyl	0.5	ICW	
			methyl parathion	1.5	LH	
Delaware[5]	500	0.25	fenvalerate	1.7 oz	A, DBM	longer PHI
		or	flucythrinate	2 oz	A, DBM	
		and	methamidophos	2 pts	A, DBM	
		or	Bt(k) new strain	2 pts	A, DBM	
		or	methomyl	2-4 pts	A, DBM	resistant
		or	permethrin	8 or 12.8 oz	A, DBM	

Table 15 Continued

Georgia[6]	5,000	0.75	*B. thuringiensis*	8-10 BTU	A, DBM	
			fenvalerate	0.1-0.2	A, DBM	longer PHI
			esfenvalerate	0.03-0.05	A, DBM	
			methomyl	0.45-0.9	A, DBM	
			methamidophos	0.5-1.0	A, DBM	
Illinois	800		permethrin	0.2	A,DBM,ICW,CL	
			fenvalerate	0.2	A,DBM,ICW,CL	
			esfenvalerate	0.07	A,DBM,ICW,CL	
			dimethoate	0.5	A,DBM,ICW,CL	
Missouri			No Alternative		LCX	
New Jersey	484	0.25	diazinon	0.5	A	longer PHI
			dimethoate	0.5	A	
			oxydemeton-methyl	0.5	A	
			methamidophos	1.0	A	
			disulfoton	1.0	A	
			esfenvalerate	0.03	CL,ICW	
			B. thuringiensis	Label	CL,ICW	
			azinphosmethyl	0.75	CL,ICW	
			methomyl	0.9	CL,ICW	
			methamidophos	1.0	CL,ICW	
			flucythrinate	0.04	CL,ICW	
			methyl parathion	1.15	CL,ICW	
			permethrin	0.2	CL,ICW	
North Carolina[7]	500	0.25	Bt Dipel	8 oz	DBM	
			permethrin	0.1	DBM	
			fenvalerate	0.2	DBM	longer PHI
			Bt Javelin		DBM	
			Pyrethroids + PBO		DBM	
New York[8]	4,000	0.5	permethrin	0.1	CL,DBM,TH	
			Bt Dipel	1.0	CL,DBM	
			Bt Javelin	1.0	CL,DBM	
			esfenvalerate	0.1	CL,DBM	
			endosulfan	0.5	CL,DBM,TH	
South Carolina[9]	450	0.5	endosulfan	1.0 +	CL,DBM,ICW	longer PHI
			B. thuringiensis	0.5		
			methomyl	0.45	CL,DBM,ICW	
			methamidophos	1.0	CL,DBM,ICW	expensive

Table 15 Continued

Utah[10]	200		methamidophos	0.5-1.0	A,CL	longer PHI
			methomyl	0.45-0.9	A,CL	
			B. thuringiensis	1-2 qts	A,CL	
			naled	2.0	A,CL	
			endosulfan	1.0	A,CL	
			permethrin	0.05-0.1	A,CL	
			parathion	0.5	A,CL	
			Malathion	0.75-2.5	A,CL	
			azinphosmethyl	0.5-0.75	A,CL	
			fenvalerate	0.1-02.	A,CL	
Wisconsin[11]	1,200	0.13-0.5	azinphosmethyl	0.5	A	longer PHI
			demeton	0.5	A	longer PHI
			diazinon	0.5	A	longer PHI
			dimethoate	0.25-0.5	A	longer PHI
			disulfoton	1.0	A	longer PHI
			endosulfan	0.5	A,CL,DBM,ICW	longer PHI
			malathion	0.5	A	
			methamidophos	0.5	A,CL,DBM,ICW	longer PHI
			naled	1.0-2.0	A,DBM,CL,ICW	longer PHI
			oxydemeton-methyl	0.5	A	
			ethyl parathion	0.25	A,CL,DBM,ICW	
			B. thuringiensis	0.5	CL,ICW,DMB	
			fenvalerate	0.05-0.2	DBM,CL,ICW	longer PHI, resistant
			methomyl	0.25-0.9	DBM,CL,ICW	
			permethrin	0.05-0.2	DBM,CL,ICW	

[1] A=aphids; CL=cabbage looper; CW=cutworm; DBM=diamondback moth; GH=grasshopper; ICW=Imported cabbageworm; LB=Lygus bug; LCX=caterpillar complex; LH=leafhoppers; LM=leafminers; M=mites; SM=saltmarsh caterpillar; TH=thrips.
[2] 25% loss
[3] 40% loss
[4] 60% loss
[5] 80% loss
[6] 50-60% loss
[7] 10% loss
[8] 20% loss
[9] 50% loss
[10] 25% loss
[11] 3-5% loss

thuringiensis satisfactory control was achieved (Table 15).

Cauliflower

Cauliflower is grown in six of the reporting states with a total of approximately 47,665 acres. California is the leading state in total acreages with 45,566 followed by Florida, Tennessee, Louisiana, New Jersey, and Oregon. Mevinphos is registered and used in all six states for control of aphids and the lepidopterous larvae. One to two applications are made each year.

Several effective alternative chemicals are used. Some of the alternatives used for aphid control are methamidophos in California, Tennessee, New Jersey, and Oregon; oxydemeton methyl, diazinon, dimethoate, and endosulfan in California. Permethrin, esfenualerate and methomyl are other alternatives which are used effectively against the lepidopterous complex in California, Louisiana, New Jersey, and Oregon. Florida and Louisiana had a problem controlling the diamondback moth with methomyl or mevinphos because of resistance. However, in Louisiana, mevinphos used in combination with *Bacillus thuringiensis* gave excellent control (Table 16).

Carrots

Three states (Florida, Texas and Wisconsin) reported the use of mevinphos (Phosdrin) on carrots. Mevinphos is registered on carrots for the following pests: aphids, leafhoppers, Lygus bugs, mites, cabbage looper, dipterous leafminer (adult), cutworm (climbing) and saltmarsh caterpillar (Table 17).

The rates of mevinphos range from 1/4 to 1/2 pint per acre for aphids and from 1/2 pint to 1 pint per acre for the other pests. The PHI is 2 days. The total acreage treated with mevinphos is 5,035 acres with an average of 1 application on carrots.

Survey results indicate that if mevinphos were not available and aphids were a problem within 1 week of harvest, a 10% loss in yield could result. Aphids could cause some damage to carrots, both early and late in the growing season. The control costs would rise some 25% when mevinphos is compared to other known chemical or nonchemical control alternatives. As few materials are registered on carrots, mevinphos is important to insect management on carrots. Mevinphos' high performance activity coupled with a short preharvest interval (2 days) make it superior to all alternatives.

Registered alternatives for aphids are malathion, diazinon, ethyl parathion, parathion (methyl) and endosulfan. The alternatives have longer PHI's: malathion (7 days), diazinon (10 days), ethyl parathion (15 days), methyl parathion (15 days), and endosulfan (7 days). These materials cannot be used on carrots should aphid populations increase rapidly within 1 week of harvest. Hence, it is important to keep mevinphos registered on carrots because of its high performance activity and its short preharvest interval.

Table 16. Use of Mevinphos on Cauliflower (average annual), 1982-1986.

State	Acres Treated	Rate (lbs. a.i./A)	Alternatives: Chemicals	Rates (lbs. a.i./A)	Pests[1]	Limitations
California[2]	31,231.94	0.25-0.75	acephate	0.5-1.0	A,CL,ICW,DBM	longer PHI
			permethrin	0.1-0.2	CL,ICW,DBM	longer PHI
			diazinon	0.25-0.5	A,CL	longer PHI
			dimethoate	0.25-0.5	A	longer PHI
			azinphosmethyl	0.5-0.75	A,CL,ICW,DBM	longer PHI
			methamidophos	0.5-1.0	A,CL,ICW,DBM	longer PHI
			oxydemeton-methyl	0.25-0.5	A	longer PHI
			endosulfan	0.25-0.75	A,CL	longer PHI
			trichorfon	0.25-0.5	CL,ICW,DBM	longer PHI
			carbaryl	0.5-1.0	CL	
			methomyl	0.45-0.9	A,CL,ICW,DBM	longer PHI
Florida	285	0.5-1.0	methamidophos	1.0	A,ICW,LM	longer PHI, highly toxic
			acephate	0.2	A,LH	
			endosulfan	1.0	A	
			permethrin	0.2	CL,ICW,LM	longer PHI, expensive
			fenvalerate	0.1-0.2	CL,ICW,CW	longer PHI, expensive
			flucythrinate	0.1	CL,SM	longer PHI, expensive
			B. thuringiensis	Label	CL,SM	
			carbaryl	0.2-0.4	GH,CW,SM	longer PHI, expensive
			ethyl parathion	0.4	CW,LM,LB,M	longer PHI, expensive
			methyl parathion	1.0	LH	longer PHI, expensive
			methomyl	0.5	ICW,SM	longer PHI, resistant
Oregon		0.25-0.5	oxydemeton-methyl	A		longer PHI
			permethrin	CL,ICW		
			methamidophos	A,CL,ICW		
			methomyl	A,CL,ICW		
Louisana	550	0.25	permethrin	0.1-0.2	CL,ICW	longer PHI
			fenvalerate	0.1-0.21	CL,ICW	longer PHI
			esfenvalerate	0.025-0.05	CL,ICW	longer PHI
			methomyl	0.25-0.5	CL,ICW	longer PHI
			B. thuringiensis	Label	CL,ICW	

Table 16 Continued

New Jersey	57	0.25	diazinon	0.5	A	longer PHI
			dimethoate	0.5	A	
			disulfoton	1.0	A	
			oxydemeton-methyl	0.5	A	
			methamidophos	1.0	A,CL,ICW	
			acephate	0.997	A,CL,ICW	
			esfenvalerate	0.03	CL,ICW	
			B. thuringiensis	Label	CL,ICW	
			azinphosemthyl	0.75	CL,ICW	
			methomyl	0.9	CL,ICW	
			flucythrinate	0.04	CL,ICW	
			permethrin	0.2	CL,ICW	
Tennessee	1,000	0.125-0.5	methamidophos	0.5-1.0	A,DBM	
			ethyl parathion	0.5	A,DBM	
			disulfoton	1.0	A	

[1] A=aphids; CL=cabbage looper; CW=cutworm; DBM=diamondback moth; ICW=imported cabbageworm; LB=Lygus bug; LH=leafhoppers; LM=leafminers; M=mites: SM=saltmarsh caterpillar.

[2] 40-50% loss

Table 17. Use of Mevinphos on Carrots (average annual), 1982-1986.

State	Acres Treated	No. Appl.	Rate (lbs. a.i./A)	Pests[1]	Alternatives	Limitations
Florida[2]	3,285	1	0.25 (aphids)	aphids	ethyl parathion	very toxic/beneficials
				CL	endosulfan	moderate control/fish
			0.50 (others)	cutworms	methomyl, BT	kills suspected resistance to methomyl
				LH, LM	ethyl parathion	moderate control
				Lygus	carbaryl	
				mites	ethyl parathion	
				SM	ethyl parathion methomyl carbaryl trichlorfon	expensive
Wisconsin[3]	250	1	0.13-0.15 (aphids)	aphids	endosulfan diazinon malathion	all except endosulfan have a long PHI
			0.5 (aster leafhopper)		ethyl parathion	hazardous/4 day PHI
				LH	carbaryl fenvalerate methomyl ethyl parathion	fewer pests controlled
Texas	1,500	1	0.125-0.25	aphids	diazinon endosulfan malathion methyl parathion ethyl parathion	
				LH	carbaryl fenvalerate malathion methoxychlor methyl parathion	
				mites	methyl parathion ethyl parathion	

[1]CL=cabbage looper; LH=leafhoppers; LM=leafminers; SM=saltmarsh caterpillar.
[2]Need is minor unless aphids cause a problem within one week of harvest, in which case 10% loss in yield could result.
[3]Need is minimal.

Celery

Four states (Michigan, Florida, Wisconsin and California) reported on the use of mevinphos on celery. Mevinphos is registered on celery for the following pests: aphids, dipterous leafminer (adult), Lygus bug, saltmarsh caterpillar, leafhopper, cabbage looper and mites.

The rates of mevinphos range from 1/4 to 1/2 pt/acre for aphids, from 1/2 to 1 pt. for other pests and 1 qt/acre for "hard-to-kill" insects. The time limitations between last spray and harvest are from 3 to 5 days depending on the rate used. The total acreage treated with mevinphos is 19,792 with an average of 1.7 applications on celery (Table 18).

Based on survey results yield decrease ranges from 2 to 45%. Aphid, lepidoptereous larval, and to a lesser extent mite, outbreaks within 1 week of harvest may result in some yield loss as well as in loss of marketability due to contamination. There is little change in control costs when mevinphos is compared to other chemical or nonchemical control alternatives. Mevinphos is a useful broad spectrum insecticide with cleanup capability that can be used close to harvest.

Registered alternatives for aphids are endosulfan, naled, parathion (ethyl) and acephate. These alternatives have longer PHI's: endosulfan (4 days), naled (7 days), parathion (ethyl) (30 days) and acephate (21 days). Alternatives do not provide adequate mite and aphid control near harvest.

Registered alternatives for cabbage looper are permethrin, acephate, B.t. and endosulfan. Other than B.t. these have a longer PHI, are extremely toxic to fish; B.t. is slow acting. Alternatives for leafhoppers are carbaryl and azinphosmethyl. Carbaryl may induce mite and aphid outbreaks. For leafminers, cyromazine may be used but it is expensive. For Lygus parathion or carbaryl may be used but they give moderate control only. And for mites, both parathion and demeton suppress mites, but are highly toxic to animals.

California considers mevinphos use necessary on its 11,562 acres of celery. There are no effective alternatives to the use of mevinphos on celery at harvest time for a broad spectrum of insect pests. Hence mevinphos continues as a viable option to late season pest control and cleanup.

Sweet Corn

Three states (Florida, Texas and California) reported the use of mevinphos on sweet corn. Mevinphos is registered on corn for control of aphids. However, mevinphos also provides some suppression of lepedopterous larvae especially as a quick knockdown product close to harvest.

The rates of mevinphos are from 1/4 to 1/2 pt. per acre for aphids. The time limitation between last spray and harvest is 2 days for mevinphos. The total acreage treated with mevinphos is 13,712 acres with an average of 1 application on sweet corn (Table 19).

Table 18. Use of Mevinphos on Celery (average annual), 1982-1986.

State	Acres Treated	No. Appl.	Rate (lbs. a.i./A)	Pests[1]	Alternatives	Limitations
Michigan	3,100	1 8 others	0.25-0.5	aphids	naled	
					endosulfan	less effective longer PHI
Florida	1,080	1	0.25 0.50	aphids others	acephate endosulfan	 moderate control and toxic to fish
					naled ethyl parathion	not effective control toxic/bad on beneficials
				CL	permethrin acephate B. thuringiensis endosulfan	toxic to fish
				LH	carbaryl azinphosmethyl	 lost effectiveness
				LM	cyromazine	expensive
				Lygus	ethyl parathion methyl parathion carbaryl	 moderate control
				mites	ethyl parathion methyl parathion demeton	 highly toxic to animals
				SM	naled	
Wisconsin	50	1	0.25-0.5	CL	B.T. endosulfan methomyl	fewer pests controlled longer PHI
				Lygus	azinphosmethyl methomyl parathion	longer PHI

Table 18 Continued

California	11,562	4	0.25-0.5	aphids	acephate	Alternative have longer PHI
				armyworm		
				CL	diazinon	
					azinphosmethyl	
					methamidophos	
					oxydemeton-methyl	
					methomyl	
					carbaryl	

[1]CL=cabbage looper; LH=leafhoppers; LM=leafminers; SM=saltmarsh caterpillar.

Table 19. Use of Mevinphos on Sweet Corn (average annual), 1982-1986.

State	Acres Treated	No. Appl.	Rate (lbs. a.i./A)	Pests[1]	Alternatives	Limitations
Florida	5,100	1	0.25	aphids	ethyl parathion methomyl endosulfan	toxic/beneficials toxic/beneficials resistance high fish kill
Texas	1,000	1	0.25	aphids	ethyl parathion oxydemeton-methyl fenvalerate endosulfan chlorpyrifos	toxic toxic phytotoxic high fish kill state registration
California	7,613	1	0.25-0.5	aphids/ lepidopterious larvae	diazinon dimethoate methomyl trichlorfon carbaryl	

There is no change in yield with or without mevinphos. There is a savings of 50% in control costs when mevinphos is compared to other chemical or nonchemical control alternatives. However, mevinphos does provide growers with another alternative in aphid control.

Registered alternatives for aphids are parathion, methomyl, endosulfan, fenvalerate and chlorpyrifos. The PHI's for these compounds are as long or longer; some are toxic to fish and beneficials, ineffective, phytotoxic or only registered in two states. The PHI's for alternatives are: parathion (12 days), methomyl (0 days), endosulfan (0 days), fenvalerate (1 day) and chlorpyrifos (21 days).

As aphids are only a problem on corn early in the season, the use of mevinphos and alternatives is not restricted or limiting. However, the use of mevinphos does provide growers with another alternative for aphid control and its use in IPM is important.

Cucumbers

Mevinphos is registered for use on cucumbers at 0.125 to 0.25 lb ai/acre for control of aphids and 0.25 to 0.50 lb ai/acre for control of grasshoppers, leafhoppers and mites. In Georgia, mevinphos is also applied to cucumber at 0.5 lb ai/acre for control of cucumber beetle and pickleworm. Use of mevinphos on cucumber occurs primarily in Florida, Georgia, New Jersey and Texas.

With the exception of pickleworm which feeds directly on the fruit, the target pests feed on the foliage and do not directly damage the harvested product. The foliage feeding pests can be effectively controlled on an "as-needed" basis when damaging infestations develop. Typically there is only limited need to control foliage feeding species once harvest begins, although aphid infestations requiring control can develop during the several week harvest period. It is in combatting these aphid infestations that mevinphos is particularly useful.

Mevinphos is used for pickleworm control only in Georgia. Pickleworm must be controlled from the onset of fruiting through harvest. Because cucumbers are harvested every 3 to 4 days, any insecticides used during the harvest period must have a very short preharvest interval; it is this feature of mevinphos (2 days PHI) that makes it well suited for this use. There are, however, several viable alternatives to mevinphos for aphid and pickleworm control during the fruiting period.

Because cucumber is a short term (65 to 75 day) crop and the insect pest problems are highly variable in intensity and frequency, naturally occurring biological control cannot be depended upon to prevent significant crop damage. Insecticidal control is important to successful cucumber production during certain periods in most, if not all, production areas. There are a number of currently registered insecticides which are viable but more expensive alternatives to mevinphos (Table 20). At present mevinphos is not essential to profitable cucumber production in any area of the US.

[illegible] in yield with [illegible] [illegible]. These [illegible] in control costs when [illegible] [illegible] compared [illegible] control alternatives [illegible] [illegible]

[illegible] is registered for use on cucurbits [illegible] aphids and 0.25 to 0.50 [illegible] [illegible] [illegible] 0.5 lb ai/acre for control of cucumber [illegible] or cucumber occurs [illegible]

[illegible] tion of pickleworm [illegible] [illegible] d on the foliage and is not directly [illegible] [illegible] feeding pests [illegible] [illegible] damaging infestation develop [illegible] control foliage feeding [illegible] ms requiring control can develop [illegible] [illegible] these which [illegible] [illegible] icularly useful.

[illegible] is [illegible] for pickleworm control only [illegible] the onset of fruiting through harvest [illegible] harvested every 3 to 4 days [illegible] [illegible] a very short preharvest [illegible] [illegible] that makes it well suited [illegible] [illegible] lternative [illegible] [illegible] g portion.

[illegible] intensity and frequency [illegible] [illegible] appended upon to prevent [illegible] [illegible] successful [illegible] [illegible] present [illegible]

Table 20. Use of Mevinphos on Cucumbers (average annual), 1982-1986.

State	Acres Treated	No. Appl.	Rate (lbs. a.i./A)	Pests	Alternatives	Limitations
Florida[1]	784	1 to 2	0.25	aphids	methamidophos	cost
					endosulfan	moderate efficacy
					emthomy	resistance suspected
					ethyl parathion	---
			0.5	grasshoppers	carbaryl	bee kills
					fenvalerate	---
			0.5	leafhoppers	carbaryl	bee kills
					fenvalerate	---
					ethyl parathion	---
			0.5	mites	ethion	limited efficacy
					dicofol	---
					ethyl parathion	---
Georgia[2]	1,000	1 to 2	0.5	aphids	endosulfan	none
					dimethoate	poor control of cucumber beetles
			0.5	cucumber beetles	carbaryl	poor control of aphids; bee kill
					endosulfan	none
					esfenvalerate	poor control of aphids
			0.5	pickleworm	endosulfan	none
					esfenvalerate	poor control of aphids
New Jersey	242	2	0.5	aphids	methamidophos	
					diazinon	long PHI
					oxydemeton-methyl	
					methomy	long reentry
					endosulfan	

Table 20 Continued

Texas	700	1	0.125-0.25	aphids	diazinon dimethoate endosulfan malathion methamidophos methyl parathion naled oxydemeton-methyl parathion phosphamidon
			0.25-0.50	leafhoppers	azinphosmethyl carbaryl diazinon dimethoate esfenvalerate ethion fenvalerate malathion methamidophos naled ethyl parathion phosphamidon
			0.25-0.50	mites	diazinon dicofol
			0.25-0.50	mites	ethion malathion methamidophos naled oxydemeton-methyl ethyl parathion phosphamidon

[1]Limitations are mild and mevinphos is not essential to cucumber production in Florida except in those instances when there is a severe aphid problem very close to harvest.

[2]Limitation are not severe. Mevinophos would be needed only if aphids develop resistance to other compounds.

Eggplant

Mevinphos was applied to eggplant acreage in the two reporting states (Florida and New Jersey) for effective and economical late-season, close-to-harvest control of leafhoppers, aphids, and mites. The alternative insecticides labeled for eggplant include endosulfan, oxymyl, carbaryl, methamidophos, and fenbutatin-oxide (Table 21).

Peppers

Mevinphos was used on 9500 acres of green bell pepper in four reporting states (New Jersey, Florida, Texas and Tennessee), probably for late-season outbreaks of mites or aphids. It was applied for the control of these two pests as well as for other insects in Florida. One to two applications were applied during the crop season. Registered alternative insecticides such as acephate and dimethoate have a longer pre-harvest interval but provide good green peach aphid control on peppers (Table 22).

Lettuce

Lettuce is grown primarily in nine states, comprising approximately 241,950 acres. California and Arizona comprise seventy to eighty percent of those acreages in the United States. All nine states recommended mevinphos for control of aphids and lepidoterous larval. In California and Arizona, mevinphos is a second choice to newer aphicides and larvicides that are recommended. These alternatives are not generally available to other states. Mevinphos is applied once or twice to the nation's lettuce crop each year.

Several effective alternative chemicals are used. However, most of them have longer pre-harvest intervals than does mevinphos. Colorado and New York reported no satisfactory alternative controls for lettuce pests (Table 23).

Melon

Mevinphos is registered for use on melons, including muskmelons and watermelons, at 0.125 to 0.25 lb ai/acre for control of aphids and at 0.25 to 0.5 lb ai/acre for control of cabbage looper, dipterous leafminer adults, leafhoppers, Lygus bugs, mites, false chinch bugs, salt-marsh caterpillars, climbing cutworms and grasshoppers. In addition it is registered at 0.25 lb ai/acre for control of the rindworm complex on watermelons. This complex includes cabbage loopers, cutworms, salt-marsh caterpillars and tobacco budworms which feed superficially on the developing fruit. There is a 2 days preharvest use restriction on all melons.

Mevinphos is used most extensively on melons in Florida and Georgia where it is applied primarily to watermelon with lesser quantities applied to cantaloupe. Mevinphos is also used in Texas on cantaloupe and honeydew melons and in California, New Jersey and North Carolina on cantaloupe and watermelons.

[illegible]hos was applied to [illegible] in [illegible] New Jersey [illegible] for effective and economical [illegible] of [illegible] aphids, and [illegible]. The alternat[illegible] labeled for [illegible] and fenbutatin [illegible] (Table 21).

[illegible]os was used on [illegible] Jersey, [illegible]rida, Texas [illegible] mites [illegible]hids. It [illegible] applied [illegible] [illegible] for [illegible] insects [illegible] the crop season. Registere[illegible] and dimethoate have a longer [illegible] aphid control on peppers (Table 22).

[illegible] is grown primarily in [illegible] states. California and Arizona [illegible] age in the United States. All [illegible] of aphids and lepidopterous larvae [illegible] a second choice to fewer applications [illegible] [illegible] these alternatives are not [illegible] applied once or twice to the [illegible]

[illegible] effective alternative chemicals [illegible] Howeve[illegible] harvest intervals that [illegible] [illegible] satisfactory alternative controls [illegible]

[illegible] registered for use on melons, including [illegible] to 0.25 lb ai/acre for control [illegible] [illegible] of cabbage looper, [illegible] leafminer and [illegible] mites, false chinch bugs [illegible] [illegible] shoppers. In addition [illegible] is registered [illegible] [illegible] [illegible] [illegible] on the developing fruit. There is [illegible]

Table 21. Use of Mevinphos on Eggplant (average annual), 1982-1986.

State	Acres treated	Pests	No. Appl.	Rate (lbs. a.i./A)	Alternatives	Limitations
Florida	240	grasshoppers leafhoppers	1	1/2	carbaryl methamidophos fenbutatin-oxide	poor control expensive expensive
New Jersey	160	aphids	2	1/4	endosulfan oxamyl oxydemeton-methyl	longer PHI

Table 22. Use of Mevinphos on Peppers (average annual), 1982-1986.

State	Acres treated	Pests	No. Appl.	Rate (lbs. a.i./A)	Alternatives	Limitations
New Jersey	1129	aphids mites	2	1/4	dimethoate acephate methomyl endosulfan	longer PHI
Florida	6980	aphids leafhoppers grasshoppers mites	1	1/4-1/2	acephate methomyl carbaryl dicofol	longer PHI highly toxic to fish
Texas	1000	aphids mites	1	1/4-1/2	dicofol acephate dimethoate	-
Tennessee	500	aphids	1	1/8-1/4	endosulfan acephate	longer PHI

Table 23. Use of Mevinphos on Lettuce (average annual), 1982-1986.

State	Acres Treated	Rate (lbs. a.i./A)	Alternatives: Chemicals	Rates (lbs. a.i./A)	Pests[1]	Limitations
Arizona		1.0	methamidophos		A,TH,AW A,TH,AW	longer PHI
California[2]	137,898	0.25-0.5	acephate	0.5-1.0	A,CL,M,TH	longer PHI
			permethrin	0.1-0.2	CL.BAW	
			diazinon	0.25-0.5	A,CL,M,BAW	
			dimethoate	0.25	A,TH	
			methamidophos	0.5-1.0	A,CL,BAW	
			oxydemeton-methyl	0.25-0.5	A,TH	
			endosulfan	0.25-0.5	A,TH,BAW,CL	
			methomyl	0.45-0.9	A,CL,BAW,TH	
			B. thuringiensis	Label	CL	
Colorado	200	0.25	No Alternatives			
Florida[3]	1,300	0.25-0.5	acephate	1.0	A,CL,TH	longer PHI
			methamidophos	0.5	A,CL,TH	
			methomyl	0.9	A,CEW,TH	
			endosulfan	0.7	A,ICW	
			ethyl parathion	0.2	A,CB,ICW,BL, M	
			methyl parathion	1.0	M	
			permethrin	0.2	CL,CEW,LM	
			flucythrinate	0.1	CL,SM	
			B. thuringiensis	Label	CL	
			carbaryl	0.1-0.15	CB,LB,ICW	
			cyromazine	0.2	LM	
			dimethoate	1.0	M	
New Jersey	484	0.25	dimethoate	0.25	A	longer PHI
			malathion	1.25	A	
			oxydemeton-methyl	0.5	A	
			methomyl	0.45	A	
			acephate	0.998	A	
			carbaryl	2.0	TPB	

Table 23 Continued

New York	925	0.25	No Alternatives			
Michigan[4]	250	0.25-0.5	dimethoate	0.125	A	longer PHI, expensive
			ethyl parathion	0.5	A	
			methomyl	0.9	A	
Texas	300	0.25-1.0	acephate	0.5-1.0	A,CL	
			diazinon	0.25-0.5	A	
			dimethoate	0.25	A	
			endosulfan	0.75-1.0	A,CL,ICW	
			methoxychlor	1.0-2.25	ICW	
			malathion	1.25-1.875	A,CL	
			methyl parathion	0.5-1.0	A,CL,ICW	
			oxydemeton-methyl	0.375-0.5	A	
			ethyl parathion	0.5	A,CL	
			B. thuringiensis	Label	CL,CEW,ICW	
			permethrin	0.1-0.2	CL,CEW,CW, ICW	
			carbaryl	1.0-2.0	ICW,CEW	
			lindane	0.4-0.5	CW	
			trichlorfon	0.5-1.0	CW	
Wisconsin[5]	600	0.125-0.5	acephate	0.75-1.0	A,CL	longer PHI
			demeton	0.25-0.5	A	
			diazinon	0.25-0.5	A	
			dimethoate	0.25	A	
			disulfoton	1.0-2.0	A	
			malathion	1.25	A,CL	
			oxydemeton-methyl	1.5-2.0	A	
			ethyl parathion	0.5	A,CL	
			endosulfan	0.75	CL	
			methomyl	0.2-0.9	CL	

[1] A=aphids; AW=armyworm; BAW=beet armyworm; CEW=corn earworm; CL=cabbage looper; CW=cutworm; ICW=Imported cabbageworm; LB=Lygus bug; LM=leafminers; M=mites; TPB=tarnished plant bug; TH=thrips.
[2] 15-20% loss
[3] 10-15% loss
[4] 5% loss
[5] 10% loss

Because of its short residual activity and 2-days preharvest interval, the principal use of mevinphos on melon crops is for insect control during the harvest period. On watermelon the primary targets are aphids and rindworms. Generally, severe damage levels of these pests can be prevented with any of several registered alternatives to mevinphos, even though some have a longer preharvest interval, if the grower monitors the developing populations and anticipates the problems.

On cantaloupe and honeydew, the targets of mevinphos use vary from state to state: in Georgia, aphids and cucumber beetles on foliage and pickleworm on fruit (see cucumber section); in Texas, various foliage feeders including aphids, cabbage looper, cutworms, leafhopper, leafminer and mites. Acceptable control in these pest situations can be achieved with registered alternatives, as is the case with control of aphids on cantaloupe and watermelon in New Jersey. In California, the alternatives diazinon and dimethoate have longer preharvest intervals and are less effective; hence, yield benefits are associated with mevinphos use in California melons (Appendix Table II.18). In North Carolina, thrips are an early to mid-season problem on foliage and fruit damage is not direct; dimethoate and carbaryl are viable mevinphos alternatives for control, although repeated applications of carbaryl can stimulate outbreaks of mites and leafminer and improperly timed applications during bloom can cause extensive bee kills. It is these factors that account for the yield benefits attributed to mevinphos relative to alternatives as shown in Table 24.

Nonchemical controls are not dependable and cannot replace the use of insecticides on melons in the foreseeable future. Naturally-occurring biological controls (parasitoids, predators and pathogens) do not provide the level of control needed. Aphid-resistant cantaloupe varieties adapted to California have been developed which will provide acceptable aphid control. Unfortunately, aphid resistant varieties adapted to areas where mevinphos is used most extensively for aphid control are not available.

Although mevinphos is used on approximately 15,500 acres of melons annually for control of a variety of insect pests, a number of acceptable alternative insecticides are currently available to replace these uses with little decrease in the level of insect control. The continued availability of mevinphos, however, would provide a valuable tool for use in the management of insecticide resistance among the insect pests of melons (Table 24).

Okra

Only Florida reported the use of mevinphos on okra. Mevinphos is registered on okra for aphids, cutworms, corn earworm, green stink bug, mites and velvetbean caterpillar.

The rate of mevinphos use on okra ranges from 1/4 to 1/2 pint per acre for aphids and from 1/2 to 1 pint for the other pests on the label. The PHI is 2 days. And with okra harvested every other day under some conditions, this short preharvest interval is critical. The total acreage treated with

Table 24. Use of Mevinphos on Cantaloupe and Watermelons (average annual), 1982-1986.

State	Acres Treated	No. Appl.	Rate (lbs. a.i./A)	Pests	Alternatives	Limitations
California	10,752	1-4	0.25	aphids	dimethoate	less efficacious
					methomyl	less efficacious
			0.5	mites	dimethoate	less efficacious
Florida	30 (cantaloupe)	1	0.25	aphids	dimethoate	
	6,000 watermelon	1			endosulfan	less efficacious
					methomyl	less efficacious
					ethyl parathion	less efficacious
			0.5	loopers	fenvalerate	resistance suspected
					Bacillus thuringiensis	resistance suspected controls only Lepidoptera
					endosulfan	low efficacy
					methomyl	resistance suspected
			0.5	cutworms	carbaryl	limited efficacy and provides no aphid control
					fenvalerate	resistance suspected
					methomyl	resistance suspected
			0.5	grasshoppers	carbaryl	
					fenvalerate	resistance suspected
			0.5	leafhoppers	dimethoate	low efficacy
					carbaryl	
					ethyl parathion	
					fenthion	
			0.5	leafminers	methamidophos	low efficacy
					naled	
			0.5	_Lygus_	fenvalerate	

Table 24 Continued

			0.5	mites	dicofol ethyl parathion	
			0.5		ethion	low efficacy
			0.5	saltmarsh caterpillars	None	
				rindworms watermelon only	fenvalerate methamidophos	some resistance high cost
					endosulfan *Bacillus thuringiensis*	high cost some resistance
				tobacco budworm	methomyl	
				chinch bugs	ethyl parathion	
Georgia watermelons	5,000	1 to 2	0.5	aphids	endosulfan dimethoate	none poor control of cucumber beetle
				cucumber beetles	carbaryl	poor control of aphids, kills bees
					esfenvalerate endosulfan	poor control of aphids none
cantaloupe	500	1	0.5	aphids	endosulfan dimethoate	
				cucumber beetles	carbaryl	poor control of aphids, kills bees
					esfenvalerate endosulfan	poor control of aphids none
				pickleworm	endosulfan esfenvalerate	none

Table 24 continued

Texas cantaloupe	1,000	1	0.125-0.25	aphids	diazinon dimethoate
honeydew	900				endosulfan malathion methamidophos methyl parathion naled oxydemeton-methyl
				aphid	parathion phosphamidon
			0.25-0.5	cabbage-looper	_Bacillus thuringienses_ endosulfan esfenvalerate fenvalerate methamidophos naled
			0.25-0.5	cutworm	carbaryl esfenvalerate fenvalerate methamidophos
			0.25-	leafhopper	azinphosmethyl carbaryl diazinon dimethoate esfenvalerate ethion fenvalerate malathion methamidophos naled parathion phosphamidon

Table 24 Continued

		1	0.25-0.5	leafminers	azinphosmethyl carbaryl diazinon dimethoate ethion malathion methamidophos naled oxamyl parathion phosphamidon	
			0.25-0.5	mites	diazinon dicofol ethion malathion methamidophos naled oxydemeton-methyl parathion phosphamidon	
New Jersey cantaloupe & watermelons	145	1	0.5	aphids	diazinon dimethoate oxydemeton-methyl methomyl endosulfan	
North Carolina[1] cantaloupe watermelon	2,000	1	0.25	thrips	carbaryl	kills bees, stimulates mite and leafminer outbreaks
					dimethoate	longer PHI

[1]Limitations of alternatives not severe.

mevinphos is 1,855 with an average of 4.5 sprays.

Survey results indicate a reduction in okra yield of 10-40% would result if mevinphos were not available. Okra is susceptible to aphids and stink bugs, especially after fruit has set. As okra is harvested many times after fruiting has begun, mevinphos with its short preharvest interval is far superior to any alternatives. None of the alternatives provide effective control during harvest.

Registered alternatives for aphids are malathion and parathion. Neither is as effective as mevinphos; parathion is very toxic to warm-blooded animals and beneficials and has a longer PHI (21 days). Malathion has a further restriction of not being registered to use after pods form.

Registered alternatives for Lepidoptera and stink bugs are malathion, parathion and carbaryl. Again malathion and parathion have longer PHI's. Carbaryl with a 0 day PHI is good, but corn earworm resistance is thought to exist (Table 25).

With none of the alternatives to mevinphos providing effective control of the broad spectrum of pests on okra, mevinphos has an important role in Florida. Likewise with the very minor nature of okra, from a pest management view it is important to retain the few registered insecticides available. The prospects of new registrations on okra seem very limited.

<u>Onions</u>

Mevinphos is used on both green and dry bulb onions in Florida, but only on the latter in Wisconsin, Texas and California. The primary pests were thrips, with cutworms also controlled in Florida. All states reported that mevinphos is both more effective than the registered alternatives and has a shorter preharvest interval (Table 26). Survey results indicate that if mevinphos were not available for thrips control, average annual yield loss of 10-20 percent in onions would have resulted (1982-1986).

<u>Parsley</u>

Only Florida reported the use of mevinphos on parsley, with 4-6 applications made to 400 acres for aphid control. Aphids are important pests of parsley because their feeding can render parsley leaves unmarketable. Mevinphos is the insecticide of choice for aphid control on parsley, primarily because of its effectiveness and short PHI. Light aphid infestations may be controlled with 0.5 lb ai/acre (PHI= 5 days) whereas high infestations or hard to kill species may require 1.0 lb ai/acre (PHI= 8 days).

The only registered alternative for aphid control on parsley is malathion which is both less effective and has a much longer PHI (21 days). The use of mevinphos provides a 20% savings in control costs as compared to the use of other known chemical or nonchemical alternatives. Further, survey

[illegible] with an average of 8.3 sprays

[illegible] indicate [illegible] are not available. [illegible] after fruit has set. [illegible] began, mevinphos [illegible] alternatives [illegible]

[illegible] alternatives for aphids [illegible] as mevinphos; [illegible] is and [illegible] a longer [illegible] not [illegible] registered [illegible]

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[illegible] alternative for aphid control on parsley is [illegible] effective and has a much longer [illegible] savings in [illegible] uneconomical [illegible]

Table 25. Use of Mevinphos on Okra (average annual), 1982-1986.

State	Acres Treated	No. Appl.	Rate (lbs. a.i./A)	Pests	Alternatives	Limitations
Florida	1,855	4.5	0.05	aphids	malathion parathion	Not as effective Very toxic to warmblooded animals and beneficials, long PHI
				corn earworm	carbaryl	Not effective (suspect resistance)
				cutworms	parathion carbaryl	
				mites	malathion parathion	
				stink bugs	carbaryl	
				velvetbean caterpillar		

Table 26. Use of Mevinphos on Onions (average annual), 1982-1986.

State	Acres treated	Pests	No. Appl.	Rate (lbs. a.i./A)	Alternatives	Limitations
Florida	750	thrips cutworms	6-8	1/2	methomyl malathion parathion	longer PHI
Wisconsin	300	thrips	2	1/2	parathion malathion diazinon	poor control
Texas	2000	thrips	-	1/2	diazinon parathion oxamyl malathion	-
California	4500	thrips	3	1/4	diazinon azinphosmethyl methomyl	longer PHI

results indicate that if mevinphos were no longer available for aphid control, parsley yields would drop an estimated 10 to 20%.

In the absence of suitable alternatives, it is important to maintain the availability of mevinphos for insect control in parsley.

Peas, green and southern

Mevinphos was used on some acreage in Wisconsin for control of pea aphids and cutworms. The alternative insecticides, dimethoate and fenvalerate do not control cutworms (dimethoate) or pea aphids (fenvalerate).

Potatoes

Three states reported the use of one application of mevinphos on potatoes for late season control of aphids, leafhoppers, and mites. Alternative insecticides labeled for control of potato insect pests include methamidophos, methomyl, parathion, carbaryl, dimethoate, and fenvalerate. Carbaryl is less effective against the insect pests, does not control mites and is highly toxic to bees. Methamidophos is more expensive and is toxic to beneficials (Table 28).

Spinach

Mevinphos is registered for use on spinach for control of aphids, cabbage looper, imported cabbageworm, grasshoppers, leafhoppers, mites, adult dipterous leafminers, climbing cutworms, saltmarsh caterpillar and false chinch bug. Registered use rates range from 0.125 to 0.25 lb ai/acre for aphids to 1.0 lb ai/acre for "hard to kill insects including aphids" (Phosdrin 4EC label) with a 4 day preharvest use restriction (Table 29).

Mevinphos is used for insect control on spinach in California, Florida, Maryland, New Jersey, New York, Oklahoma, Texas, and Virginia, with the most extensive use in New Jersey, New York, Oklahoma, Texas and California. Although in Florida and Texas, some use of mevinphos is directed against many or most of the insects listed on the Phosdrin 4EC label, the primary targets of use in all states are aphids. Aphid populations can develop rapidly. Early season infestations, if uncontrolled, can cause severe stunting or even death of the plants. Infestations which develop close to harvest are particularly serious because they constitute a source of insect contamination of the harvested crop. Whereas viable alternatives exist for control of early season aphid infestations (e.g. parathion, dimethoate, diazinon, disulfoton, azinphosmethyl, endosulfan and methyl parathion) none of the alternatives are considered to be effective for controlling aphid infestations close to harvest either because of limited efficacy or preharvest intervals that are too long. Of the remaining insect pests, loopers, cutworms, grasshoppers, imported cabbage worm and salt marsh caterpillars are chewing insects which

Table 27. Use of Mevinphos on Peas (green and southern) (average annual), 1982-1986.

State	Acres treated	Pests	No. Appl.	Rate (lbs. a.i./A)	Alternatives	Limitations
Wisconsin (green)	500	aphids	1	1/4	fenvalerate	poor aphid control
		climbing cutworms			dimethoate	
Tennessee (southern peas)	250	aphids	3	1/8-1/4	dimethoate disulfoton	

Table 28. Use of Mevinphos on Potatoes (average annual), 1982-1986.

State	Acres treated	Pests	No. Appl.	Rate (lbs. a.i./A)	Alternatives	Limitations
Idaho	100	green peach aphid	1	1/4	methamidophos endosulfan	none
Florida	658	aphids mites leafhoppers	1	1/4-1/2	methamidophos methomyl carbaryl fenvalerate	toxic to beneficials, expensive, moderate control
Texas	2000	aphids leafhoppers mites	1	1/8-1/4	dimethoate endosulfan	

Table 29. Use of Mevinphos on Spinach (average annual), 1982-1986.

State	Acres treated	No. Appl.	Rate (lb. ai/A)	Pests	Alternatives	Limitations
California	4,000	1-2	0.25	aphids	diazinon	longer PHI
					dimethoate	longer PHI
					azinphosmethyl	longer PHI (14 days)
			0.5	cabbage-looper	methomyl	longer PHI
				beet armyworm	azinphosmethyl	longer PHI
Florida	125	1	0.5	aphids	naled	poor control
					ethyl parathion	poor control
					malathion	poor control
			0.5	cabbage-looper	fenvalerate	resistance suspected
						long PHI
					Bacillus thuringiensis	expensive; controls only Lepidoptera
					ethyl parathion	
			0.5	cutworms	fenvalerate	long PHI
					carbaryl	long PHI
					methomyl	long PHI
			0.5	grasshoppers	carbaryl	long PHI
					fenvalerate	long PHI
					malathion	poor control
			0.5	imported cabbage worm	fenvalerate	long PHI
					methomyl	long PHI
					Bacillus thuringiensis	
					endosulfan	reduced control

Table 29 Continued

			0.5	leaf-hoppers	dimethoate carbaryl	reduced efficacy does not control aphids
					parathion	
			0.5	mites	ethyl parathion methyl parathion	
Florida	125	1	0.5	saltmarsh caterpillar	methomyl	resistance suspected; long PHI
					parathion	
Maryland	100	4-5	0.25	aphids	dimethoate	14 day PHI would lead to increased aphid contamination
New Jersey	597	1	0.25	aphids	diazinon dimethoate disulfoton	longer PHI
New York	600	1-2	0.12-0.25	aphids	none	no other materials with short enough PHI to eliminate insect contamination
Oklahoma	2,000	2	0.25	aphids	dimethoate	poor control of Lepidoptera
					ethyl parathion	14 day PHI
				looper	ethyl parathion methomyl	14 day PHI reduced control
Texas	1,000	1	0.125-0.25	aphids	azinphosmethyl diazinon dimethoate endosulfan malathion methyl parathion naled	

Table 29 Continued

Texas	1,000	1	0.125-0.5	cabbage-looper	*Bacillus thuringiensis*	
					methyl parathion	
			0.125-0.5	cabbage-looper	naled	
					ethyl parathion	
					permethrin	
			0.25-0.5	cutworm	diazinon	
					permethrin	
			0.25-0.5	leaf-hopper	carbaryl	
					dimethoate	
					methoxychlor	
					methyl parathion	
					ethyl parathion	
					permethrin	
			0.25-0.5	mites	azinphosmethyl	
					methyl parathion	
					ethyl parathion	
Virginia	400	2-3	0.25	aphids/leaf-miner	diazinon	PHI too long
					dimethoate	
					disulfoton	can be used at planting only and does not provide full season control
					permethrin	(leafminers only) not labeled for aphids

feed on the foliage. Heavy infestations early in the season can slow plant growth and even cause plant death whereas lighter infestations can severely reduce quality through feeding damage on harvested leaves. For this reason damage thresholds for these insects approach zero and infestations are prevented from becoming established. There are a number of equally effective alternatives for control of these pests on spinach, except in the unusual situation where a larval infestation exists close to harvest and must be controlled to prevent insect contamination of the marketable commodity.

Spider mite feeding on spinach results in a yellow stippling of the foliage which reduces the quality of the harvested produce. Mite infestations at the time of harvest thus must be controlled. Methyl and ethyl parathion are alternatives to mevinphos for mite control on spinach.

There are registered alternative insecticides which will control all of the important insect pests attacking commercially grown spinach in the US. The activity spectra and the longer preharvest intervals of the alternatives preclude their use as viable replacements for mevinphos as a "clean up" treatment close to harvest to prevent insect contamination of the marketable crop. Thus, yield benefits are associated with mevinphos use.

There are no effective alternatives to the use of insecticides for spinach. Parasitoids, predators, and pathogens cannot be depended upon to prevent damaging infestations of chewing insects from developing. Although parasitoids and fungal pathogens will often prevent aphid populations from reaching levels which damage the plant through direct feeding injury, aphids killed by these natural enemies become stuck to the spinach foliage and become a major source of insect contamination of the harvested crop. In essence these natural enemies constitute as severe a problem as the aphids and their presence must be prevented through efficient aphid control.

Squash

Mevinphos is registered for use on summer squash at 0.125 to 0.25 lb. ai/acre for control of aphids and at 0.25 to 0.50 lb ai/acre for control of cabbage looper, dipterous leafminer adult, leafhoppers, *Lygus* bugs, mites, false chinch bugs, salt marsh caterpillar, climbing cutworm and grasshoppers. The short preharvest interval (2 days) makes mevinphos attractive for use on summer squash during the period when the crop must be harvested approximately every three days.

Most mevinphos use on summer squash takes place in Florida and Georgia. It is used in Florida primarily during the harvest period for control of aphids, mites and *Lygus*. Aphid and mite populations develop on the foliage. *Lygus* feeding on developing fruits can lead to misshapen and aborted fruits, and, hence, reduced yield and quality. Although, a wide variety of other insect pests can be controlled on summer squash in Florida by mevinphos, other insecticides (Table 30), because of their longer residual activity, are preferred except during the harvest period, at which time the short preharvest interval and broad activity spectrum makes mevinphos the preferred insecticide.

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for control of ... pests on spinach, except ...
are larval infestation exists close to harvest ...
prevent insect contamination of the marketable commodity.

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registered alternative insecticides which ... against pests attacking commercially grown ... spectra and the longer preharvest intervals ... use as viable replacements for methomyl ... close to harvest to prevent insect contamination ... yield benefits are associated with methomyl ...

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is registered for use on summer squash at 0.225 to ... trol of aphids and at 0.25 to 0.50 lb active ... spp., diaprous leafminer adult, leafhopper, ... salt marsh caterpillar, climbing cutworm and ... st interval (2 days) makes methomyl attractive ... ring the period when the crop must be harvested approximately ...

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Table 30. Use of Mevinphos on Squash (average annual), 1982-1986.

State	Acres treated	No. Appl.	Rate (lb. ai/A)	Pests	Alternatives	Limitations
Florida						
summer squash	1,500	1	0.25	aphids	ethyl parathion methomyl endosulfan	
			0.5	cabbage-looper	fenvalerate endosulfan _Bacillus thuringiensis_	
			0.5	cutworms	fenvalerate methomyl ethyl parathion	
			0.5	chinch bugs	ethyl parathion carbaryl	
			0.5	grass-hoppers	fenvalerate carbaryl	
			0.5	leaf-hoppers	naled parathion oxamyl	
			0.5	lygus	ethyl parathion fenvalerate	
			0.5	mites	dicofol ethion	
Florida						
summer squash	1,500	1	0.05	mites	ethyl parathion	
			0.5	saltmarsh caterpillar	methomyl	

Table 30 Continued

Georgia	3,000	2 to 3	0.5	aphids	endosulfan	none
					dimethoate	poor control of cucumber beetle
			0.5	cucumber beetle	carbaryl	poor control on aphids; bee kills
					endosulfan	none
					esfenvalerate	poor control of aphids
			0.5	pickle-worm	endosulfan	none
					esfenvalerate	poor control of aphids

In Georgia, mevinphos use on summer squash is directed against aphids and cucumber beetles, which feed on the foliage, and pickleworm which feeds on the fruit. Aphids and cucumber beetles, if properly controlled during the preharvest period, rarely develop damaging infestations during the harvest period. The pickleworm, because it infests the fruits, must be controlled from first bloom through harvest.

As with most vegetable crops, nonchemical controls and naturally occurring biological control cannot be depended upon to provide a reliable and acceptable level of insect control on summer squash. Insecticides are needed to achieve acceptable levels of control on summer squash. However, viable alternatives to mevinphos (e.g., endosulfan) are registered for use on summer squash. The loss of mevinphos would not impose severe constraints on summer squash production in either Florida or Georgia unless resistance to the alternatives were to develop in one or more of the key pest species. The yield benefits attributed to mevinphos use are associated with its use during the harvest period.

Tomatoes

Four states (Florida, New Jersey, Arkansas and Texas) reported using mevinphos on tomatoes for control of aphids, leafhoppers, leafminers, and mites. Approximately 7,000 acres received 1 to 2 treatments of mevinphos primarily for late season aphid control near harvest. Alternatives labeled for tomatoes are diazinon, dimethoate, methomyl, and dicofol. All have longer preharvest intervals than mevinphos. Based on the survey results the need for mevinphos usage on tomatoes did not appear significant except for late season outbreaks of aphid or mite populations during the harvest period (Table 31).

Leafy Greens - Turnip, Mustard and Kale

Seven states (Illinois, New Jersey, Oklahoma, South Carolina, Tennessee, Georgia and Louisiana) reported the use of mevinphos on leafy greens (turnip, mustard and kale) (Table 32). Mevinphos is registered on leafy greens for the following pests: aphids, cabbage looper (CL), imported cabbage worm, grasshoppers, leafhoppers, salt-marsh caterpillar, mites, climbing cutworms, leafminer (adult), lygus bugs and false chinch bugs. More recent use of mevinphos has been directed toward diamondback moth.

The rates of mevinphos range from 1/4 to 1/2 pint per acre for aphids and from 1/2 to 1 pint for the other pests on the label. The PHI is 3 days. The total acreage treated with mevinphos is 19,031 with an average of 2.5 applications per crop season.

Survey results indicate that yield decrease without mevinphos ranges from 0 to 50%. Some contamination by aphids and caterpillars occurs and is of occasional economic concern in the processing industry. Mevinphos is the best aphicide available for use on greens, the only material registered for mite control, the material of choice for diamondback moth and an excellent

[illegible] when used is [illegible] [illegible] it [illegible] which feed on [illegible] foliage, and [illegible] [illegible] [illegible] and cucumber beetles. [illegible] are well controlled [illegible] rarely develop damaging infestations [illegible] cabbageworm, because it [illegible] the fruits [illegible] control [illegible] through [illegible]

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[illegible] (Florida, New Jersey, [illegible] [illegible] [illegible] tomatoes for control of aphids [illegible] [illegible] [illegible] 7,000 acres received [illegible] [illegible] late season aphid control [illegible] [illegible] [illegible] dimethoate, [illegible] [illegible] intervals than mevinphos [illegible] [illegible] usage [illegible] tomatoes [illegible] outbreaks of aphids or mite populations [illegible]

[illegible] Collards and Kale

[illegible] (Illinois, New Jersey, Oklahoma, South Carolina [illegible] [illegible]) reported no use of mevinphos on [illegible] [illegible] kale (Table 32). Mevinphos is registered [illegible] [illegible] aphids, cabbage looper, [illegible] [illegible] grasshoppers, salt-marsh caterpillar, mites [illegible] [illegible] bugs and [illegible] cabbageworms. [illegible] been a [illegible] toward [illegible]

[illegible] of mevinphos range from 1/4 to 1/2 [illegible] [illegible] to 1 pint for the other pests [illegible] [illegible] treated with mevinphos is 15,021 [illegible] [illegible] per crop season.

[illegible] indicate that yield decreases [illegible] [illegible] [illegible] [illegible] contamination [illegible] [illegible] processing [illegible] [illegible] for use [illegible] only [illegible] [illegible] [illegible] for [illegible] and an [illegible]

Table 31. Use of Mevinphos on Tomatoes (average annual), 1982-1986.

State	Acres treated	Pests	No. Appl.	Rate (lbs. a.i./A)	Alternatives	Limitations
Florida	4500	aphids leafhoppers grasshoppers mites	1	1/4	dimethoate diazinon methomyl dicofol	longer PHI late season aphid control
New Jersey	1040	aphids mites	2	1/4	dimethoate diazinon methomyl dicofol	longer PHI
Arkansas	1000	mites	2	1/4-1/2	none	-
Texas	400	aphids leafhoppers leafminers	1	1/8-1/4	-	-

Table 32. Use of Mevinphos on Leafy Greens (Turnip, Mustard, Kale) (average annual), 1982-1986.

State	Acres Treated	No. Appl.	Rate (lbs. a.i./A)	Pests	Alternatives	Limitations
Georgia[1]	17,000	3.5	0.75	diamondback moth (DMB) aphids grasshoppers	_B. thuringiensis_ fenvalerate methomyl endosulfan	No cleanup spray for DBM collards only not effective no DBM, long PHI
Louisiana[2]	250	3.5	0.25 - 0.5	aphids DBM stinkbugs	malathion azinphosmethyl methyl parathion (Penncap-M) naled B.T. fenvalerate permethrin	less residual limited Appl. PHI limited crop registrations (not mustard)
Oklahoma[3]	800	2	0.25	aphids	naled dimethoate malathion parathion	not for aerial application long PHI not effective for CL long PHI long PHI
South Carolina[4]	900	4	0.5	DBW imported cabbageworm aphids	endosulfan B.T. methomyl	Phosdrin okay 21 day PHI no control of DBM expensive no control of DBM 10 day PHI
Illinois[5]	500	2	0.5 - 1.0	green peach aphid cabbage worms	dimethoate B. T.	Longer PHI worm control only
Tennessee[6]	1,200	6	0.12 - 1.0 0.12 - 1.0	aphids caterpillars	dimethoate parathion	Longer PHI

Table 32 Continued

New Jersey	81	1	0.25	aphids	dimethoate	
				mites	carbaryl	mevinphos is only material registered for mite control
				ICW	_B. thuringiensis_	
				CL	methomyl	

[1]Cleanup spray at harvest; reduction in quality if mevinphos is not used.

[2]Little change in yield and no change in quality.
Where DBM is a problem mevinphos is an excellent alternative in a "rotating" schedule.
No material alone is effective.

[3]Crop Rejection est. 5-15% - Loss.
Aphids are the major late season pest and create serious problems in contaminating the crop.
Clean up alternative is naled which cannot be applied by air.
Ground application limited due to irrigation and time constraints.

[4]Yield loss 50%.
Decreased quality due to insect damage caused by DBM.
Only recommended material for DBM (essential).

[5]Some contamination by insects.
Need not essential.

[6]No yield effects.
Aphids present when processing (some concern)
Mevinphos is best aphicide on greens.

material in an insecticide rotation schedule and as a cleanup spray.

Registered alternatives for aphids are dimethoate, malathion, endosulfan, parathion, azinphosmethyl, and naled. They have less residual activity against aphid, have longer preharvest intervals than mevinphos, and none is registered for mites. Some of the alternatives cannot be applied by air. In addition they are expensive and in the case of diamondback moth, ineffective.

With no single, effective alternative superior to mevinphos for a broad spectrum of pests and with their serious limitations, mevinphos remains the product of choice in most situations.

Leafy Greens - Collards

Four states (North Carolina, South Carolina, Alabama and Florida) reported the use of mevinphos on collards (Table 33). Mevinphos is registered on collards for the following pests: aphids, cabbage looper, imported cabbage worm, grasshoppers, leafhoppers, salt-marsh caterpillar, mites, cutworms (climbing), leafminer (adult), Lygus bugs. More recent use of mevinphos has been directed against diamondback moth due to the occurrence of resistance to other registered insectcides. In this use pattern a tank mix of mevinphos and one of the *Bacillus thuringiensis* formulations has proven most effective in the management of resistant diamondback moth populations.

The rates of mevinphos range from 1/4 to 1/2 pt/acre for aphids, from 1/2 to 1 pt. for other pests and 1 qt/acre for hard to kill insects. The time limitation between last spray and harvest is from 2 to 3 days depending on the rate used. The total acreage treated with mevinphos is 3,781 with an average per state of 5.25 applications on collards.

Survey results indicate that yield decrease without mevinphos ranges from 5 to 50%. Aphids are the major late season pest and create a serious problem in contaminating the crop. The contamination may be direct (insects, cast skins), or indirect (honeydew, sooty mold, necrotic leaves, holes). Processed greens also may be contaminated with grasshoppers, leafminers and diamondback moth (DBM). Mevinphos is the single best material that is effective as a clean-up treatment near harvest. As a result of label limitations and more recently the development of diamondback moth resistance to several pesticides, mevinphos is the only effective material that will control diamondback moth in addition to managing a broad range of pests. Mevinphos has the advantage of having a short preharvest interval (3 days), of being registered for both ground and aerial application, of being relatively inexpensive, and of having a long history in broad spectrum activity as a clean-up treatment. Added value with mevinphos comes from its use in a tank mix with *Bacillus thuringiensis* (Dipel or Javelin) for the management of resistant diamondback moth populations throughout the southeast and its full season use in a rotating schedule and in an integrated pest management approach. For latest information as to DBM resistance refer to the regionalized cooperative study under the directions of Drs. Anthony M.

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Collards

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... of mevinphos range from 1/4 to 1/2 lb/acre ...
... other pests and 1 lb/acre for hard to kill insects ...
... between last spray and harvest ... from 1 to 3 days ...
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... and more recently the development of diamondback ...
... esticides, mevinphos is the only effective material that will
... ondback moth in addition to managing a broad ... of ... pests.
... advantage of having a short preharvest interval ...
... of both ground and aerial application ...
... nsive and of having a long history ...
... ean-up treatment. Added ... use of mevinphos ...
... with *Bacillus thuringiensis* (Dipel ...) for the
... nt diamondback ... throughout the ...
... in a rotation ... and ... an integrated ...
... for latest information ... is to ... rest ...
... ve study under the ...

Table 33. Use of Mevinphos on Leafy Greens (Collards) (average annual), 1982-1986.

State	Acres Treated	No. Appl.	Rate (lbs. a.i./A)	Pests	Alternatives	Limitations
North Carolina[1]	2,000	8	0.5	diamondback moth (DBM) aphids	methomyl fenvalerate	Not effective where resistant populations occur. No aphid control with these materials PHI (methomyl) (10)
					B. thuringiensis	Slow action
South Carolina[2]	1,000	7	0.5	DBM	endosulfan	Endosulfan 21 days, PHI, expensive.
					fenvalerate	No DBM control; toxic to fish
					B. thuringiensis	
Alabama[3]	400	5	0.5	DBM	methomyl	10 day PHI
					B. thuringiensis	Less control
					diazinon & *B. thuringiensis*	
Florida[4]	381	1	0.5	imported cabbageworm leafminer	fenvalerate	DBM resistance, highly toxic to fish
				lygus	methomyl	DBM resistance
				mites	*B. thuringiensis*	expensive
				salt-marsh caterpillar	endosulfan	provides only moderate control
				cabbage looper	dimethoate	not effective
				cutworms	carbaryl	resistance suspected
				grasshoppers aphids	parathion	highly toxic to warm-blooded animals and beneficials
					naled, diazinon, malathion	does not provide effective control

[1]Est. 10% loss in yield with alternatives. More where resistant populations exist. Severe cases results in nonmarketable greens.

[2]Yield 5%. Decreased quality due to DMB damage.

[3]25% yield loss due to DBM. Quality decreased greatly.

[4]5-10% yield loss
Aphids & LM before harvest results in reduced quality of collards.

Shelton (Cornell University) and Jeffrey Wyman (University of Wisconsin).

Mevinphos as a tank mix with Bacillus thuringiensis (B.T.) has received endorsement of most universities and has been the "stop-gap" measure adopted by growers where DBM resistance exists or is suspected.

Registered alternatives for aphids are naled, parathion, diazinon and malathion and provide inadequate aphid control and all have a longer preharvest interval than mevinphos (3 days at 1/4 to 1/2 pt/acre and 7 days at 1 qt/acre) i.e. naled (4 days), parathion (10 days), diazinon (10 days), and malathion (7 days).

Registered alternatives for control of Lepidoptera (cabbage looper, imported cabbage worm, diamondback moth, salt-marsh caterpillar, climbing cutworms, corn earworm, and velvet bean caterpillar) are fenvalerate, B.T., parathion, carbaryl, methomyl and endosulfan. The limitations of lack of effective and timely control exist for all of the above materials. Slow mode of action (B.T.); ineffectiveness against cabbage looper and diamondback moth by parathion, fenvalerate, carbaryl, methomyl and endosulfan; increased comparative cost of B.T., fenvalerate, carbaryl, methomyl and endosulfan; high toxicity of parathion and methomyl; danger of fish kills with fenvalerate and endosulfan; suspect or documented resistance by diamondback moth to fenvalerate and methomyl and the long preharvest interval between last spray and harvest of fenvalerate (7 days), parathion (10 days), carbaryl (14 days), methomyl (10 days), and endosulfan (21 days and can be used only once per season), individually and collectively make the use of alternatives unacceptable. Likewise, similar limitations exist for the other pests listed earlier. In particular the long preharvest interval for those materials listed earlier and for dimethoate (14 days).

There are no other effective alternatives to the use of insecticides in the management of pests on collards at present. Rotation, natural and biological control, resistant varieties, and new pesticide chemistry offer some hope but their realization and adopted use is neither practical nor likely to be commercially available in the foreseeable future. Hence, mevinphos remains the most viable approach in pest management on collards.

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f m[illegible] unter[illegible] [illegible] has been [illegible]
[illegible] resistance [illegible] is [illegible]

d alternatives for aphids are [illegible]
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commercially available in the [illegible]
mains the most viable approach [illegible]

GREENHOUSE

Mevinphos (Phosdrin 4 EC) is registered for use on greenhouse-grown lettuce (including leaf, bibb and romaine). Pests controlled are aphids, corn earworms, climbing cutworms, dipterous leafminer adults, cabbage looper, imported cabbageworm, grasshoppers, mites, _Lygus_ bugs, salt-marsh caterpillars, false chinch bugs and thrips. Rates to be applied are 0.625-0.155 lb. a.i/50,000 sq.ft. Pre-harvest interval is 10 days.

None of the states surveyed reported any greenhouse use of mevinphos.

Greenhouse

Phosdrin 8 EC is registered [illegible] lettuce grow-
ng leaf, bibb and romaine. [illegible] aphids,
limbing cutworms, omnivorous leaf roller adults, cabbage looper, [illegible]
worm, [illegible] mites, [illegible] bugs, [illegible]
lso chinch bug and thrips. [illegible]
000 sq.ft. [illegible] interval is 10 days.

[illegible] states surveyed reported any greenhouse use of [illegible]

AERIAL APPLICATION

The aerial application of mevinphos was reported in the Columbia Basin of Washington to alfalfa grown for seed production, in California, Nevada, Oregon and Pennsylvania to alfalfa grown for hay and in Florida to parsley and in Oklahoma to greens. The use of mevinphos on alfalfa grown for seed and for hay is discussed in the Field Crops section of this report and the use of mevinphos on parsley is considered in the Vegetable Crops section. Mevinphos was not applied by air to large acreages and was not considered as essential by any reporting state.

SEWAGE PLANTS, SYSTEMS AND BIOFILTERS

One state, Missouri, reported on our questionnaire that mevinphos is occasionally used to control flies which breed in the filters of sewage disposal plants.

If not controlled, these flies may build up to the point that their larvae and pupae clog filters, and the adults become a nuisance to plant employees and to persons living nearby. It was reported that over the period 1982-86, an average of 1-2 cities per year treated flies at their sewage plants with mevinphos. Because no other state reported the use of mevinphos for this purpose, either the situation is unique to Missouri or is not considered a problem in other areas, or the crop oriented respondents to our questionnaire were unaware of this use in their state.

When used for this purpose, mevinphos is applied 1-2 times per year, at a rate of 0.35 pounds per 100 gal. It is obviously applied only when the flies have become a problem or are expected to do so. The Missouri questionnaire indicated that there is no alternative insecticide. The obvious advantage of using mevinphos is that it has a broad spectrum of toxicity, yet it hydrolyses very rapidly, thus causing little downstream risk. It is not known whether *Bacillus thuringiensis* var. *israelensis* has been evaluated for these pests. *B. thuringiensis* would impact a more limited spectrum of organisms, but would persist further downstream.

ECONOMIC AND SOCIAL IMPACTS

Methodology and Data

Comparative static equilibrium analysis is used to demonstrate the benefits of mevinphos. The estimated impact of mevinphos use is determined by comparing yields, prices, and production with the expected use of mevinphos's alternatives.

The economic benefits of mevinphos are the higher yields attained with its use in addition to its lower costs relative to many insecticides for controlling pests on major vegetable and fruit crops. In addition, it is important in a few major field crops.

The benefits of mevinphos were calculated as the sum of reduced revenues plus added costs that would result from the withdrawal of mevinphos. Presumably, growers are now using mevinphos because it is more profitable than alternative pesticides or control methods. If mevinphos were withdrawn from use, a grower could be expected to experience the following results:

1) reduced yield (from decreased quantity or quality),

2) increased costs associated with the use of a more expensive alternative treatment, and/or

3) increased market prices (from aggregate reductions in crop supplies).

The methodology used is derived from estimating

$$B = \sum_{i=1}^{n} (R_0 - R_1 + C_1 - C_0)$$

where:

B = Average annual net benefits of mevinphos,
R_0 = Average annual revenue in the base period (1982-86) with the use of mevinphos,
R_1 = Average annual revenue in the future without mevinphos,
C_1 = Average annual costs of control in the future without mevinphos, and
C_0 = Average annual costs of control in the base period (1982-86),
i = a site in a particular state, and
n = total number of sites.

Benefits were summarized by state, by region, and by site to determine the impact of the withdrawal of mevinphos.

The methodology assumes the following:

a) A parallel shift in the supply of a commodity due to a change in yield results in a change in the quantity of that commodity demanded, holding other factors constant. The Economic Analysis Simulator (EAS) developed by Walter Ferguson (1989) of USDA Economic Research Service is used to generate the results.

b) The yield benefit of using mevinphos instead of its alternatives is known for each commodity. Survey responses are used to estimate the yield benefit of mevinphos by asking crop production experts for the yield loss from using mevinphos's alternatives. The percentage shift in aggregate supply is an average, weighted by mevinphos-treated and non-mevinphos-treated production. Non-mevinphos-treated production is the total U.S. production minus the product of mevinphos-treated acreage and yield.

c) The price response following a yield-induced shift in supply is estimated using a price flexibility of demand. Farm-level flexibilities were obtained from econometric analyses of 1954-1988 data, including own-price, per capita consumption, price of substitutes, and selected other factors (summarized in APPENDIX IV).

d) The cost change from using mevinphos's alternatives is additional to any yield, price, and value of production changes for a commodity. Survey responses are used to estimate the cost changes associated with mevinphos's alternatives.

Quantitative Use of Mevinphos

The total amount of mevinphos used annually in the United States during 1982-86 averaged 756,815 pounds active ingredient (a.i.) (Table 34). The total acreage treated averaged 666,723 acres. The treated acreage received an average of 1.14 pounds a.i. per acre. The total annual treatment cost of mevinphos use averaged $13,612,000, about $20.42 per acre. This total includes application and chemical costs. The total cost of alternatives to mevinphos treatment averaged $15,491,000 or about $23.23 per acre.

Vegetables were treated with an average of 594,777 pounds a.i. of mevinphos annually during 1982-86. This amounts to 78.6 percent of the total mevinphos applied (Table 34). Fruit crops (mainly strawberrry) received 103,977 pounds a.i. or 13.7 percent of the total. Field crops (mainly alfalfa seed) received 58,061 pounds a.i. or 7.7 percent of the total.

Vegetable acreage treated with mevinphos was 547,067 acres, 82.1 percent of the total acreage treated. Total annual cost of mevinphos treatment on vegetables was $11,309,000, an 83.1 percent share of the total costs of treatment. The per acre cost of treatment with mevinphos averaged $20.67 for vegetables, $18.44 for field crops, and $22.39 for fruit crops. The per acre

Table 34. Survey responses: Acreage and acreage treated with mevinphos, mevinphos applied, and control costs with and without mevinphos available, by crop type and region (average annual), 1982-86.

Crop Type or Region[1]	Acreage reported	Acreage treated	Mevinphos applied[2] (pounds a.i.)	Control Costs: Current (1,000 dollars)	Control Costs: Alternative[3] (1,000 dollars)
Vegetables	1,264,702	547,067	594,777	11,309	12,708
Field crops	885,107	95,320	58,061	1,758	947
Fruits	779,482	24,336	103,977	545	1,836
Northeast	117,780	13,964	7,601	236	221
North Central	204,180	9,900	5,388	166	115
South	592,261	107,035	223,476	900	4,946
South Central	746,380	79,743	75,678	815	2,061
West	1,229,096	445,400	435,104	11,348	8,029
Northwest	39,594	10,682	9,568	147	119
Total	2,929,291	666,723	756,815	13,612	15,491

[1]For regional definitions, see Note 1 at end of section.
[2]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.
[3]Acreage treated with mevinphos times average cost of chemical and/or nonchemical control alternatives.

cost of treatment with alternatives to mevinphos averaged $23.23 for vegetables, $9.93 for field crops, and $75.44 for fruit crops.

The West region averaged the largest share of mevinphos use, 57.5 percent. The South region was next with 29.5 percent. The others accounted for 13 percent (Table 34). In terms of acreage treated, the West region had 66.8 percent of the total treated, the South had 16.1 percent, the others had 17.1 percent. In terms of total treatment costs, the West had 83.3 percent of the total, the South had 6.6 percent, and the others had 10.1 percent. Of the total cost of alternatives to mevinphos, the West had 51.8 percent, the South had 31.9 percent, and the others had 16.3 percent.

In terms of the total acreage treated or mevinphos applied, lettuce is the most important crop, followed by alfalfa seed, broccoli, cabbage, greens, and strawberry (Table 35). Other important crops are cauliflower, celery, and muskmelons. For crops such as artichoke, carrot, southern pea, okra, and spinach which do not account for a large proportion of either acreage or mevinphos used, the use of mevinphos is important, as more than half their acreage reported was treated with mevinphos.

The largest shares of the total cost of using mevinphos are in lettuce (41.2 percent), alfalfa seed (12.7 percent), broccoli (11.1 percent), and cauliflower, cabbage, and celery (total 14.7 percent) (Table 35). The largest shares of total cost of alternatives to mevinphos use are in lettuce (25.0 percent), cabbage (16.4 percent), greens (11.5 percent), strawberry (10.2 percent), broccoli (8.8 percent) and alfalfa seed (6.0 percent).

The net cost advantage of using mevinphos over its alternatives on all crops is $1,879,000, but the difference varies widely over individual crops. Higher total costs of using alternatives to mevinphos occur mainly in cabbage, greens, and strawberry. Lower total costs of using alternatives to mevinphos occur mainly in lettuce, where the yield benefit of 7,501,000 hundredweight (cwt.) offsets the higher cost of using mevinphos. Alternative costs are lower in alfalfa seed production also, but the yield benefit is offsetting.

The estimated yield benefit of mevinphos ranges widely over different crops (Table 36). In descending order, the crops with high relative yield benefits on treated acreage are artichoke (45.0 percent), strawberry (44.3 percent), and cauliflower (40.3 percent). Crops with a yield benefit in the range of 20 percent to 30 percent include celery, onion, and okra. Crops with a yield benefit in the range of 10 to 20 percent include broccoli, Brussels sprouts, cabbage, sweet corn, muskmelons, lettuce, parsley, and spinach.

The last column of Table 36 lists the aggregate yield benefit of mevinphos on the basis of total U.S. acreage (treated and untreated with mevinphos). Nine crops have a significant aggregate yield benefit from mevinphos use: broccoli (6.4 percent), cabbage (8.9 percent), cauliflower (20.4 percent), celery (8.0 percent), greens (3.8 percent), muskmelons (3.1 percent), lettuce (12.1 percent), strawberry (10.2 percent), and spinach (14.2 percent). In the markets for these crops with significant yield

Table 35. Survey responses: Acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop	Acreage treated	Mevinphos applied[1] (pounds)	Yield benefit[2] (1,000 cwt.)	Control Costs: Current	Control Costs: Alternative[3]
				(——1,000 dollars——)	
Alfalfa, seed	92,800	56,801	12	1,740	928
Apple	4,740	3,740	8	134	137
Broccoli	61,892	71,764	689	1,510	1,368
Brussels sprouts	3,000	1,710	28	55	30
Cabbage	46,310	63,597	2,367	606	2,537
Pea, southern	250	141	---	2	7
Carrot	3,535	1,326	14	25	32
Cauliflower	34,400	35,445	1,401	802	296
Celery	15,743	19,143	1,478	595	535
Greens	24,985	69,667	198	180	1,775
Corn, field	820	410	---	6	12
Sweet corn	12,712	7,060	145	213	106
Cucumber	10,126	3,337	---	74	199
Eggplant	401	160	---	4	8
Grape	11,419	6,509	50	210	114
Muskmelons	38,463	17,271	622	529	527
Lettuce	209,500	241,748	7,501	5,610	3,867
Onion	5,550	6,300	673	179	77
Parsley	400	1,000	9	3	11
Pea, english	500	125	---	8	3
Pepper	17,769	5,284	24	145	271
Potato	658	247	---	7	17
Sorghum	1,700	850	---	12	7
Squash	4,650	4,369	14	40	88
Strawberry	8,177	93,729	1,025	201	1,585
Tomato	6,922	3,543	83	77	99
Turnip	200	100	---	2	1
Artichoke	10,000	5,700	344	184	100
Bean, lima	23	17	<1	<1	1
Bean, snap	10,169	6,188	2	102	264
Okra	1,855	4,174	19	17	72
Spinach	13,910	16,040	187	204	134
Watermelon	13,145	9,323	26	139	283
Total	666,723	756,815		13,612	15,491

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.
[2]Yield benefit equals percent change in yield times production treated with mevinphos.
[3]Acreage treated with mevinphos times average cost of chemical and/or nonchemical control alternatives.

Table 36. U.S. crop production: Mevinphos-treated farm production and yield benefit, U.S. aggregate farm production, farm price, and yield benefit, by crop (average annual), 1982-86.

	Mevinphos-treated		U. S. aggregate		
Crop	Farm production (1,000 cwt.)	Yield benefit (percent)	Farm production (1,000 cwt.)	Farm price (dollars/cwt.)	Yield benefit (percent)
Alfalfa seed	805	1.5	1,651	97.13	0.7
Apple	630	1.3	80,827	11.44	0.0
Broccoli[1]	5,642	12.2	10,767	22.86	6.4
Brussels sprouts	285	10.0	---	---	---
Cabbage[1]	12,798	18.5	26,732	7.67	8.9
Pea, southern	8	---	---	---	---
Carrot	387	3.7	23,450	9.49	0.1
Cauliflower[1]	3,479	40.3	6,875	25.41	20.4
Celery[1]	5,419	27.3	18,443	12.89	8.0
Greens[1]	3,736	5.3	5,262	22.79	3.8
Corn, field	195	0.0	4,167,561	4.23	0.0
Sweet corn	1,357	10.7	15,131	12.89	1.0
Cucumber	1,106	0.0	---	---	---
Eggplant	81	0.0	---	---	---
Grape	832	6.0	14,279	20.15	0.0
Muskmelons[1]	5,574	11.2	19,895	13.07	3.1
Lettuce[1]	62,097	12.1	62,031	11.57	12.1
Onion	2,856	23.6	42,436	9.13	1.6
Parsley	62	15.0	---	---	---
Pea, english	15	---	---	---	---
Pepper	1,868	1.3	5,729	22.12	0.4
Potato	150	0.0	364,055	20.44	0.0
Sorghum, forage	NA	7.5	NA	NA	0.2
Sorghum, grain	20	2.5	406,537	3.94	0.0
Squash	649	2.2	---	---	---
Strawberry[1]	2,314	44.3	10,097	45.77	10.2
Tomato	3,575	2.3	28,592	24.01	0.3
Turnip	NA	---	---	---	---
Artichokes	763	45.0	---	---	---
Bean, lima	1	2.5	---	---	---
Bean, snap	372	0.4	---	---	---
Okra	63	30.0	---	---	---
Spinach[1]	1,324	14.2	4,474	25.54	14.2
Watermelon	1,497	1.8	24,499	5.69	0.1
Total	120,336	14.1			

[1]See note 2 at end of text.

SOURCES: For mevinphos-treated production and yield effects--1988-89 survey of states. For U.S. aggregate production and price--U.S. Department of Commerce, 1982 Census of Agriculture, National Summary; USDA, National Agricultural Statistics Service, Crop Production, annual issues; USDA, National Agricultural Statistics Service, Crop Values, annual issues.

effects, the benefits of mevinphos include lower prices. For the other crops, with less than 2 percent yield benefit over total U.S. production, the price effects are considered negligible and the total benefits amount to a cost differential to the growers.

Yield, Price, and Crop Value Benefits

The yield benefit of mevinphos with respect to price is assumed to be a result of higher supplies and lower price to consumers. That is, considering total production, the higher yield causes price to be lower, holding other factors constant. For producers of a commodity exhibiting relatively stable (or inflexible) prices, higher production means higher total crop value. (For a recent example of similar considerations, see Barse, Ferguson, and Seem.)

The price characteristics of selected vegetables are given for 1954-1988 in Table 37. The minimum, maximum, and mean price vary widely over different crops; the coefficient of variation (the ratio of the standard deviation to the mean) is similar among crops. The price flexibilities of demand were calculated from price-dependent equations. Farm-level own-price was regressed on per capita use and the farm-level price of all other vegetables, using Ordinary Least Squares regression. The per capita use quantities were adjusted for carryover stocks and net exports, and all prices were deflated by the Gross National Product deflator (1982=100). For all items, other adjustments were made. For example, utilization differences, consumer income, and binary variables were included where necessary. (APPENDIX IV)

The average value of fresh-market vegetables, regressed on per capita use and deflated U.S. disposable personal income, exhibits price-flexible demand at the farm level (Table 37). The individual items, though, exhibited price-inflexible demand. This is a likely result for several reasons. First, individual items may substitute for one another, compared to the aggregate group which has fewer substitutes. Second, the quantities of individual items are all less than the aggregate group, which lowers the flexibility estimate, ceteris paribus. Third, the vegetables with the lowest flexibilities are of a type including cauliflower and broccoli that may have more substitutes than a type including lettuce which is consumed regularly in combinations with other foods.

Selected items of interest from the output generated by Economic Analysis Simulator are summarized in Table 38. The estimates are based on acreage in production, proportion of production treated with mevinphos, changes in yield, farm-level price, and price flexibility of demand. Only those crops with a yield benefit from mevinphos large enough to affect the U.S. domestic market are included. For a comparison of production and crop value with and without the availability of mevinphos, percentage changes are presented in Table 39.

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Table 37. U.S. price characteristics for selected crops (average annual), 1954-88.

Crop[2]	Farm-level price[1] Min.	Max.	Mean	C.V.	Flexibility[3]
	(——dollars/cwt.——)				
Broccoli	7.36	25.23	13.64	0.45	-0.49
Cabbage[4]	1.56	8.63	4.12	0.52	-0.82
Cauliflower	5.90	26.16	13.85	0.54	-0.21
Celery	3.11	13.68	6.90	0.46	-0.67
Greens[4]	---	---	---	---	-0.82
Muskmelons[4]	3.85	14.09	7.04	0.42	-0.70
Lettuce	3.28	15.19	7.10	0.48	-0.80
Strawberry	14.17	49.41	28.76	0.39	-0.53
Spinach[4]	5.69	27.36	12.06	0.52	-0.19
Fresh-market vegetables[5]	4.03	15.55	8.08	0.48	-2.45

[1]Min.=minimum, Max.=maximum, C.V.=coefficient of variation, flexibility of farm-level price with respect to quantity demanded.
[2]Fresh-market (dual-purpose uses for broccoli, cauliflower, and strawberry).
[3]Defined as the percentage change in price per one-percent change in quantity used. Estimated with 1982-86 average quantity and predicted price.
[4]Estimated from 1954-81 data only. Due to lack of data, greens given the spinach flexibility. Muskmelons are cantaloupe in this table.
[5]Includes broccoli, cauliflower, celery, honeydew melons, lettuce, carrots, sweet corn, onions, tomatoes.

SOURCE: Computed from USDA, Agricultural Statistics, Annual issues

Table 38. U.S. price, production, and value of production for selected crops resulting from the unavailability of mevinphos.

Crop	U.S. Farm-Level		
	Price ($/cwt.)	Production (1,000 cwt.)	Value (1,000 dollars)
Broccoli	23.24	10,406	241,789
Cabbage	7.94	25,593	203,157
Cauliflower	25.96	6,165	160,050
Celery	13.09	18,009	235,796
Greens	23.29	5,120	119,267
Muskmelons	13.15	19,722	259,336
Lettuce	12.69	54,526	691,928
Strawberry	46.34	9,861	456,929
Spinach	25.74	4,286	110,338

SOURCE: Calculated from Economic Analysis Simulator (Ferguson)

Table 39. Summary of economic impact on U.S. crop producers resulting from the unavailability of mevinphos, as compared to 1982-86 average annual, by crop.

Crop	Farm-level		Farm value		Control costs (1,000 dollars)
	Production (percent)	Price (percent)	Absolute (1,000 dollars)	Relative (percent)	
Alfalfa, seed	-	-	-	-	-812
Apple	-	-	-	-	+3
Broccoli	-3	+2	-4,345	-2	-142
Brussels sprouts	-	-	-	-	-25
Cabbage	-4	+4	-1,877	-1	+1,931
Pea, southern	-	-	-	-	+5
Carrot	-	-	-	-	+7
Cauliflower	-10	+2	-14,644	-8	-506
Celery	-2	+2	-1,934	-1	-60
Greens	-3	+2	-654	-	+1,595
Corn, field	-	-	-	-	+6
Sweet corn	-	-	-	-	-107
Cucumber	-	-	-	-	+125
Eggplant	-	-	-	-	+4
Grape	-	-	-	-	-96
Muskmelons	-1	+1	-692	-	-2
Lettuce	-12	+10	-25,771	-4	-1,743
Onion	-	-	-	-	-102
Parsley	-	-	-	-	8
Pea, english	-	-	-	-	-5
Pepper	-	-	-	-	+126
Potato	-	-	-	-	+10
Sorghum	-	-	-	-	-5
Squash	-	-	-	-	+48
Strawberry	-2	+1	-5,211	-1	+1,384
Tomato	-	-	-	-	+22
Turnip	-	-	-	-	-1
Artichoke	-	-	-	-	-84
Bean, lima	-	-	-	-	+1
Bean, snap	-	-	-	-	+162
Okra	-	-	-	-	+55
Spinach	-4	+1	-3,928	-3	-70
Watermelon	-	-	-	-	+144
Total			-59,056	-2	+1,879

At the farm level, oppposite changes in production and price are nearly offsetting in cabbage, celery, greens, muskmelons, and strawberry. Due to the estimated inflexibility of prices for broccoli, spinach, and especially cauliflower, decreases in U.S. production are not as nearly offset by increases in price. Lettuce price would increase the most because its yield benefit from mevinphos is the greatest and its demand is relatively price responsive. Therefore, the yield benefit of mevinphos is proportionately greater on these latter four crops compared to the others. The benefit of mevinphos use, based on changes in crop value, totals $59.1 million. The largest benefit comes from use on lettuce, followed by cauliflower, strawberry, broccoli, spinach, and celery.

In addition to the benefit of mevinphos on crop value, the net change in production costs for mevinphos's alternatives amounts to $1.9 million (Table 39, column 4). The major cost increases of substituting chemical and other means to control pests previously controlled by mevinphos would occur on cabbage (+$1.9 million), greens (+$1.6 million), and strawberry ($1.3 million). Offsetting reductions in costs for substituting mevinphos's alternatives could occur in lettuce (-$1.7 million), alfalfa seed (-$0.8 million), and cauliflower ($-0.5 million).

The average annual net benefit of mevinphos in U.S. crop production, adding the change in total crop value to the net change in control costs, is $60.9 million or about $91 per acre treated. This estimate of total benefit is sensitive to different estimates of yield change and price flexibility. For example, a lower absolute value for price flexibility produces a higher value of any yield benefit from mevinphos use. Also, the net difference in mevinphos's alternative control costs are assumed to be borne entirely by the producer and not passed on to the consumer. The availability of mevinphos is likely to be a risk reducing (and thus cost reducing) opportunity for producers, suggesting an unmeasured benefit. Finally, for producers and farm labor, mevinphos may pose other risks which are not taken into account here.

Consumer Benefits

The benefits to consumers of a product treated with mevinphos are assumed to be measured by the difference in retail price that would be paid for the product treated instead with mevinphos's alternatives. Based on the farm-level yield and price effects of mevinphos (Table 39), assuming mevinphos is unavailable and assuming the price change is passed on to the retail level of distribution, consumers benefit from mevinphos use on broccoli, cabbage, cauliflower, celery, greens, muskmelons, lettuce, strawberry, and spinach.

Annual average retail prices are available for comparison with farm-level prices for several major fresh-market vegetables (Economic Research Service). The correlation coefficients estimated from 1970-1988 data are high and statistically significant for carrot (0.98), celery (0.97), lettuce (0.97), onion (0.85), and tomato (0.98). On average, during 1982-86 a one percent change in the farm-level price resulted in a 0.96 percent change in the retail price of celery and a 1.2 percent change in the retail price of lettuce. Assuming similar relationships between farm-level and retail prices

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[illegible] million), greens (+$1.6 million), and [illegible]
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cauliflower (-$0.5 million).

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[illegible] in total crop value [illegible] control costs [illegible]
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[illegible] risk reducing (and thus cost reducing) [illegible]
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[illegible] consumers of a product treated [illegible]
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[illegible] reduction, consumers benefit from methoprene use on
[illegible] flower, celery, greens, muskmelons, lettuce

[illegible] are available for crops [illegible]
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[illegible] cauliflower (0.96), celery (0.97) [illegible]
[illegible] (0.98) [illegible] average, during 1982-8[illegible]
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for broccoli, cabbage, cauliflower, greens, muskmelons, strawberry, and spinach, the yield benefit of mevinphos on these crops is likely to be lower prices also. The retail price benefit in percentage terms is likely to be on the order of estimates listed in Table 39 (column 2).

The consumers' total benefit from mevinphos use results from the lower prices paid for total production caused by the lower marginal value of the increased yield. Instead of using retail prices, which are unavailable for most of the items affected, farm-level prices and quantities are used to calculate the consumer's benefit from mevinphos. The product of the change in price times the total production of crops whose yield is increased by using mevinphos equals $94 million, comprising broccoli ($4 million), cabbage ($7 million), cauliflower ($3.6 million), celery ($3.7 million), greens ($2.6 million), muskmelons ($1.6 million), lettuce ($65 million), strawberry ($5.6 million), and spinach ($0.9 million).

The total benefit of mevinphos use is the sum of the increased production costs expected with mevinphos's alternatives ($1.9 million), the higher farm value of production ($59 million), and the higher consumer value of production ($94 million). The total benefit of mevinphos use is $155 million--61 percent of which is received by the consumer of the farm product.

Of course, in the event that mevinphos is unavailable, higher prices will put pressure on the market to adjust by increasing supply, possibly through increasing imports or through changes in production practices. The present analysis does not attempt to estimate market adjustments; it is intended to indicate where pressure for adjustment is more likely to occur.

Macroeconomic Effects

The commodities benefitting from mevinphos use occupy a relatively minor share of U.S. gross national product and require relatively minor shares of U.S. labor and capital. Also, the price and income impacts of mevinphos unavailability would likely cause negligible changes in inflation and interest rates.

Social/Community Impacts

Employment impacts in local areas where particular crops are important might occur. These could result from one or both of the following: (1) a crop may no longer be grown in specific local areas if mevinphos is unavailable; and (2) slowdown in packing houses and with shippers in cases where the rejection rate for produce due to insect damage becomes very high or packing houses shut down due to the loss of a crop.

These are very important events to the affected individuals and communities, in the short run, but are fairly minor for individual states or nationally. For the most part, crops on which mevinphos is used (i.e. fresh produce) are produced in areas where soil and climate are favorable for a wide range of crops. Therefore, there are usually alternative uses for land and labor.

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mates listed in Table 39 [illegible]

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[illegible] total production caused by the [illegible]
[illegible] instead of using retail prices, [illegible]
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consumer's benefit from mevinphos. [illegible]
the total production of crops whose [illegible]
[illegible] equals [illegible] million, comprising broccoli [illegible]
cauliflower ($3.5 million), celery [illegible]
melon ($1.6 million), lettuce [illegible]
spinach ($0.9 million).

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Notes

1. Regions are defined as:

   Northeast: Connecticut, Delaware, Maryland, Massachusetts, Maine, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont
   North Central: Iowa, Illinois, Indiana, Michigan, Missouri, Minnesota, Ohio, Wisconsin
   South: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisianna, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia
   South Central: Colorado, Kansas, Montana, North Dakota, Nebraska, Oklahoma, South Dakota, Texas, Wyoming
   West: Arizona, California, New Mexico, Nevada, Utah
   Northwest: Idaho, Oregon, Washington
   Other: Alaska, Hawaii, Guam, Puerto Rico, Virgin Islands, District of Columbia

2. U.S. aggregate farm production was estimated for cabbage, greens (collards, kale, mustard greens, turnip greens), muskmelons (cantaloupe and honeydew), and spinach by multiplying the 1982 Census of Agriculture estimate of 1982 acreage times the average yield calculated from mevinphos respondents. For broccoli, cauliflower, lettuce, and strawberry, USDA-estimated 1984-86 average production was used. For celery, USDA-estimated 1982-86 average production was used.

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[illegible]ast: Connecticut, Delaware, Maryland [illegible]
[illegible]w Hampshire, New [illegible] [illegible]
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[illegible]entral: Iowa, Illinois, Indiana, Mich[illegible]
[illegible]esota, Ohio, Wisconsin
[illegible] [illegible]: Arkansas, Florida, Georgia, [illegible]
Mississippi, North Carolina, South Carolina, [illegible]
West Virginia
[illegible] Central: Colorado, Kansas, Mon[illegible], Nor[illegible]
[illegible]ahoma, South Dakota, Texas, Wyoming
[illegible]izona, California, New Mexico, Neva[illegible]
[illegible]: Idaho, Oregon, Washington
[illegible]: Alaska, Hawaii, Guam, Puerto Rico, Virgin [illegible]
[illegible] of Columbia

[illegible] 1987 farm production was estimated [illegible]
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[illegible] and spinach by multiplying [illegible]
of [illegible] acreage times the average yield [illegible]
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[illegible]erage production was used.

EXPOSURE CONSIDERATIONS AND THEIR RELATIONSHIP TO RISK ANALYSIS.

In general, our knowledge of the exposure and environmental risks from the use of mevinphos are incomplete (EPA 1988). Nevertheless, we can conclude some general trends based upon our knowledge of its general toxicity and residual longevity (Matsumura 1985).

Mevinphos is a highly toxic, broad spectrum cholinesterase inhibitor. It is highly toxic to a broad range of beneficial insects, birds, fish, and mammals. Most animals in or adjacent to an area to which mevinphos is applied are at risk. The following acute toxicity dosages have been reported: sharp-tailed grouse, 1.34 mg/kg dermal; mallard duck, 4.63 mg/kg dermal, 1991 ppm oral; Japanese quail, 236 ppm oral; rainbow trout, 11.9 ppb 96-hr; bluegill sunfish, 22.5 ppb 96-hr; sheepshead minnow, 640 ppb LC_{50}; *Daphnia pulex*, 0.18 ppb; and *Pteronarcys californica*, 5.0 ppb (EPA 1988). Nevertheless, no documented field kills of wildlife have been noted (EPA 1988). This is probably because mevinphos is rapidly hydrolyzed in aqueous solution (Hayes 1982). Mevinphos is one of the preferred insecticides for use on alfalfa grown for seed. On this crop the alfalfa leafcutting bee and the alkali bee are essential pollinators and must be carefully conserved. Insecticide treatments are applied exclusively at night when the pollinators have returned to their nests. The short residual properties of mevinphos reduces to acceptable levels the hazards to the bees working the treated crop the next day (Alfalfa Seed Industry 1989). The available information on the impact of mevinphos on non-target organisms may be summarized as: its acute toxicity to exposed organisms is very high, but its residual effect appears to be slight.

The physiological effects of mevinphos on rats, human volunteers, and accounts of accidents are included in an earlier section (Pesticide Characteristics). More details are reported by Hayes (1982). Poisoning reports from California indicate that mevinphos was among the top five pesticides causing occupational poisoning in that state from 1981-85. These were primarily from dermal exposure, with some from inhalation (EPA 1988). Thus, extreme caution must be exercised when working with mevinphos or working in an area where mevinphos is being applied. On the other hand, as with non-target organisms, a relatively short pre-harvest interval and a short treated field reentry period are probably justified, based on the rapid rate of hydrolysis of mevinphos residues.

Data currently available are insufficient to characterize mevinphos's leaching potential for contamination of ground water, but they indicate that its residues are highly mobile in sandy loam, silt loam, loam, and clay loam soils (EPA 1988). This is not surprising since technical mevinphos is miscible in water (Hayes 1982). Nevertheless, its water contamination potential is likely to be small because of its susceptibility to hydrolysis.

Because of the extremely high level of toxicity of mevinphos, it is crucial that label instructions be followed and that persons using this chemical be fully instructed in the appropriate safety measures. The acute toxicity hazard is such that mevinphos should be used only when other less hazardous alternative insecticides are not available. If used properly and

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[illegible]siological effects of mevinphos on [illegible] human [illegible] accidents are included in an earlier section [illegible] ics). More details are reported by Hayes (1982) [illegible] California indicate that mevinphos was among the [illegible] ausing occupational poisoning in that state from 1951 [illegible] ly from dermal exposure, with some from [illegible] caution must be exercised when working with [illegible] area where mevinphos is being applied. On the other hand [illegible] nisms, a relatively short pre-harvest interval [illegible] reentry period are probably justified, based on the [illegible] of mevinphos residues.

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cautiously, residue and toxicity problems should be minimal. The residue hazard is probably not a major factor.

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a major factor.

RECOMMENDATIONS

The recommendations contained herein are based on the assumption that the alternatives (pesticides) listed for specific site/pest/crop use remain viable. Loss of registration or availability of these alternatives to mevinphos would require a re-examination of recommendations listed below.

Based upon the results of the benefits analysis the continued registration of mevinphos on the following sites is considered essential:

a. Strawberry - because the short preharvest interval allows for effective control of insect pests during a long harvest period characterized by frequent harvests at short intervals.

b. Alfalfa for seed - because the short period of residual toxicity to pollinators uniquely allows for insect pest control while protecting essential pollinators.

c. Artichoke, Beans (pole), Broccoli, Cabbage, Cauliflower, Celery, Lettuce, Okra, Onions, Parsley, Spinach, Leafy Greens (including Collards) - because the short preharvest interval of mevinphos on these crops uniquely provides for a broad spectrum of insect control close to harvest. In these crops this is essential to avoid insect damage to and contamination of harvested produce.

The economic analyses revealed significant economic benefits associated with mevinphos use on all of the crops listed above except artichoke, beans, okra, onions and parsley. For these latter, however, the pest control requirements are such that none of the available alternatives constitute fully acceptable alternative in all production areas.

The continued availability of mevinphos on commodities other than those listed above contributes 1) to grower ability to respond to rapid pest outbreaks, especially close to harvest and 2) to the diversity of insecticides available to counteract the development of resistance.

According to questionnaire response, mevinphos has only limited usage on the following commodities:

Field Corn
Popcorn
Sorghum (grain and forage)
Peaches
Pears
Plums
Sour cherries
Oranges
Lemons
Grapefruit
Raspberries
Walnuts

Cited usage in this report and the recommendations voiced by the mevinphos assessment team indicates that further or future support for use in mevinphos should be addressed on a commodity by community basis and contingency of resistance alternative insecticide.

Mevinphos is highly toxic and may enter the body by ingestion or by dermal contact. As such, mevinphos is classified as a Category I pesticide and the risk of acute poisoning is documented. As a result it is imperative that industry representatives continue to explore safer formulation or safer means of handling and applying mevinphos. In addition, extension and pesticide specialists should continue to instruct and train growers, farm managers, applicators and field labor on the safe handling and use of mevinphos to reduce and avoid occupational poisoning. Efforts to obtain additional base data on occupational poisoning should be documented and validated as to misuse and to accidental or intentional misuse.

Mevinphos appears to have a 'niche' in its directed use on several commodities in several regions of the U.S. However, research and adoption of alternative chemical and nonchemical tactics for insect management should continue to be integrated into the production and marketing of an economic, stable and safe food supply in a clean environment.

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[illegible] that further [illegible]
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[illegible] into the production and marketing of [illegible] commodities.
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APPENDIX I

Mevinphos (Phosdrin)
Questionnaire

(Please provide a separate questionnaire for each registered crop and/or use in your State). Reporting State:______________________________

USE EXTRA SHEETS AS NEEDED FOR ANY QUESTION.

1. Crop/site: ____

1a. Please provide the following information regarding this crop:

Total acres of crop (Average 1982-1986) ________________ Acres

Total production (Average 1982-1986), specify units _____________

Total crop value (Average 1982-1986) $________________________

2. Target Pest(s) ____

____

____

3. Average number of acres (or please state other appropriate units) treated with mevinphos per year. Average for 1982-1986 ________________.

4. Average number of treatments per acre (or please state other appropriate units) for all pests on this crop. Average for 1982-1986 ________.

5. Rate, active ingredient per acre per application (or please state other appropriate unit). Average for 1982-1986 ____________________.

6. Cost per acre (or please state other appropriate unit) per application
   a. Material $________________________

   b. Application (include labor plus machinery costs or custom rate)

   $________________________

7. Is mevinphos applied as part of an operation that would take place regardless of whether or not mevinphos is applied (e.g. applied in conjunction with regular fungicide application, etc.)?
   (Yes or No): ____________________.

   If yes, please describe the operation: ________________________

   ____

8. Assume that mevinphos is no longer available. List the Chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos. Estimate the percent of mevinphos treated acreage on which each practice would be applied.

Alternative Practice (Chemical or Nonchemical)	Percent of Mevinphos-treated acres that would be treated with the new practice	Pesticide application rate (lbs. a.i. per acre)	Average number of treatments per treated acre	Cost per treatment per acre

9. a. Please give the limitations or disadvantages of each alternative (e.g. longer post harvest interval, controls fewer pests and name pests controlled by each alternative, resistance, hazard to user and/or non-target organisms, environmental concerns, etc.): ____________

b. What is the degree of each limitation (e.g. severe, mild, insignificant): ____________

c. Advantages, if any, of each alternative relative to mevinphos:

10. Benefits of mevinphos vs. registered alternatives:

a. Given the use of alternative practices above, estimate the percent change in yield or marketable product per acre on acreage currently treated with mevinphos. Indicate yield loss or gain:

b. Quality effects, type and degree: ____________

c. Other (e.g. short Post Harvest Interval, Resistance Management, etc.)

(Please provide references and/or data on an additional sheet or sheets where available for question 10. Best guesses should be provided if that is all that is available).

11. Please provide any available economic data on use and benefits of mevinphos and/or alternatives (or indicate other data sources you are aware of).

12. Does your state recommend mevinphos or alternatives (please specify which ones) and enclose a copy of your recommendations.

13. Do you perceive a need for (specific needs for pest) registration of mevinphos on this crop (site)? Please indicate extent of need (e.g. essential, important, limited, not needed). State your reasons.

14. Your Name ______________________________

Address ______________________________

____

Telephone ______________________________

If you have questions contact Bobby Pass at 606-257-7450.

Please return completed questionnaire (s) by August 15, 1988 to:

Bobby C. Pass
Department of Entomology
University of Kentucky
Lexington, Kentucky 40546-0091

APPENDIX II

Survey responses by commodity: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available, 1982-86

U.S. production by commodity: Mevinphos-treated farm production and yield benefit, U.S. aggregate farm production, farm price, and yield benefit, by crop, 1982-86

Survey responses by commodity: Acreage, production, value, 1982-1986

Appendix Table II.1. Survey responses for vegetables: Acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
Broccoli	112,622	61,892	71,764	12.2	25.53	23.06
Cabbage	83,158	46,310	63,597	18.5	13.09	54.78
Muskmelons	55,230	38,463	17,271	11.2	13.77	13.71
Carrot	15,060	3,535	1,326	3.7	7.08	9.01
Cauliflower	51,337	34,400	35,445	40.3	23.31	8.60
Celery	30,973	15,743	19,143	27.3	37.77	33.97
Greens	33,142	24,985	69,667	5.3	7.20	71.06
Lettuce	233,496	209,500	241,748	12.1	26.78	18.46
Onion	10,110	5,550	6,300	23.6	32.17	13.82
Pepper	38,100	17,769	5,284	1.3	8.14	15.24
Potato	32,900	658	247	0.0	9.90	25.66
Spinach	22,299	13,910	16,040	14.2	14.64	9.62
Sweet corn	67,020	12,712	7,060	10.7	16.75	8.36
Tomato	58,370	6,922	3,543	2.3	11.10	14.37
Watermelon	109,610	13,145	9,323	1.8	10.56	21.56
Subtotal	953,427	505,493	567,756	13.8	21.40	23.59
Other	311,275	41,574	27,021	12.2	11.79	18.85
Total	1,264,702	547,067	594,777	13.7	20.67	23.23

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.2. Survey responses for field crops: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
Alfalfa, seed						
California	100,000	84,300	48,051	1.0	19.13	10.00
Oregon	8,862	2,500	1,250	1.0	12.75	10.00
Washington	25,000	6,000	7,500	12.5	60.00	10.00
Total	133,862	92,800	56,801	1.5	18.75	10.00
Corn, field						
Colorado	660,000	320	160	---	8.49	30.00
Florida	46,200	500	250	---	7.00	4.79
Total	706,200	820	410	---	7.58	14.63
Sorghum, forage						
Florida	25,000	1,250	625	7.5	7.00	4.17
Sorghum, grain						
Florida	20,045	450	225	2.5	7.00	3.91
Total	45,045	1,700	850	7.2	7.00	4.10
Total	885,107	95,320	58,061	2.9	18.44	9.93

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.3. Survey responses for fruit crops: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
Apple						
Illinois	14,000	1,500	450	0.0	22.50	15.00
New Jersey	5,280	40	90	0.0	37.50	10.00
New York	64,400	3,200	3,200	1.5	31.00	35.50
Total	83,680	4,740	3,740	1.3	28.36	28.80
Grape						
California	676,700	11,419	6,509	6.0	18.38	10.00
Strawberry						
California	13,342	3,000	3,420	60.0	41.25	194.24
Florida	5,160	5,160	90,300	15.0	261.98	194.24
New Jersey	600	17	9	0.0	10.00	10.00
Total	19,102	8,177	93,729	44.6	24.60	193.86

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.4. Survey responses for broccoli: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
New Jersey	400	65	16	---	7.50	10.00
Alabama	600	300	750	25.0	35.00	37.00
Florida	236	71	27	7.5	6.92	14.33
Texas	7,500	7,500	15,000	---	14.50	14.33
Arizona	10,874	12,427	24,854	---	33.50	52.40
California	90,700	40,372	30,683	17.5	24.00	14.33
Oregon	2,312	1,156	434	---	24.00	15.70
Total	112,622	61,892	71,764	12.2	24.39	22.10

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.5. Survey responses for cabbage: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
Delaware	850	500	438	---	31.50	10.00
New Jersey	3,000	484	121	---	7.50	10.00
New York	12,000	4,000	2,000	20.0	15.00	10.00
Illinois	3,500	800	800	---	10.50	10.00
Wisconsin	5,500	1,200	1,125	4.0	30.00	10.00
Alabama	700	100	250	25.0	35.00	36.80
Florida	14,190	10,461	11,769	30.0	18.75	52.40
Georgia	7,000	5,000	5,700	55.0	20.10	72.00
North Carolina	12,000	500	3,000	10.0	45.78	47.52
South Carolina	500	475	1,425	50.0	42.00	75.75
Tennessee	1,500	1,000	1,124	---	18.96	47.52
Texas	16,040	16,040	32,080	---	14.50	72.00
California	6,178	5,550	3,691	40.0	23.63	52.40
Utah	200	200	75	25.0	12.00	10.00
Total	83,158	46,310	63,597	18.5	13.09	54.78

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.6. Survey responses for carrot: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
Wisconsin	4,300	250	94	---	18.00	10.00
Florida	10,760	3,285	1,232	5.0	6.25	8.94
Total	15,060	3,535	1,326	3.7	7.08	9.01

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.7. Survey responses for cauliflower: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
New Jersey	350	57	14	---	7.50	10.00
Florida	1,200	285	214	---	11.00	8.38
Texas	1,800	1,800	3,600	---	14.50	8.38
California	44,567	31,232	31,232	45.0	24.50	8.38
Oregon	3,420	1,026	385	---	24.00	15.70
Total	51,337	34,400	35,445	40.3	23.31	8.60

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.8. Survey responses for celery: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
Michigan	3,100	3,100	1,163	2.0	10.75	9.70
Florida	9,040	1,080	405	2.5	5.75	39.92
California	18,833	11,563	17,576	37.5	48.00	39.92
Total	30,973	15,743	19,143	27.3	37.77	33.97

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.9. Survey responses for greens (collards, turnips, kale, mustard): States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
New Jersey	500	81	20	---	7.50	10.00
Illinois	2,500	500	750	---	17.00	12.75
Alabama	1,200	400	1,000	25.0	35.00	60.40
Florida	1,269	381	191	7.5	9.10	5.91
Georgia	17,000	17,000	44,625	---	23.45	72.00
Louisiana	2,000	250	438	---	24.50	60.40
North Carolina	4,000	2,000	16,000	10.0	61.04	109.60
South Carolina						
greens	1,000	950	1,900	50.0	28.00	52.50
collards	1,000	950	3,325	50.0	49.00	85.75
Tennessee	1,200	1,200	900	---	39.96	109.60
Virginia	473	473	118	17.0	8.25	10.00
Oklahoma	1,000	800	400	10.0	10.40	20.00
Total	33,142	24,985	69,667	5.3	7.20	71.06

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.10. Survey responses for sweet corn: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
Florida	53,020	5,100	1,275	---	5.17	8.36
California	14,000	7,612	5,785	17.5	24.50	8.36
Total	67,020	12,712	7,060	10.7	16.75	8.36

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.11. Survey responses for muskmelons: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
Florida	1,500	30	11	5.0	12.46	13.71
Georgia	9,000	500	250	---	5.50	13.71
Texas						
cantaloupe	22,180	22,180	5,545	---	7.25	13.71
honeydew	5,000	5,000	1,250	---	7.25	13.71
California	17,550	10,753	10,215	32.5	30.63	13.71
Total	55,230	38,463	17,271	11.2	13.77	13.71

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.12. Survey responses for lettuce: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
Florida	3,000	484	121	---	7.50	10.00
New York	3,700	925	347	25.0	11.25	10.00
Michigan	1,000	250	94	5.0	10.75	8.59
Wisconsin	800	600	150	10.0	15.00	8.59
Florida	13,220	1,300	853	12.5	10.06	18.58
Colorado	500	200	100	---	8.63	8.59
Texas	2,700	270	135	---	7.25	8.59
Arizona	59,126	67,573	135,146	---	33.50	18.58
California	149,450	137,898	104,803	17.5	24.00	18.58
Total	233,496	209,500	241,748	12.1	26.78	18.46

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.13. Survey responses for onion: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
Wisconsin	1,580	300	300	---	32.00	21.96
Florida	830	750	2,625	15.0	64.96	13.35
California	7,700	4,500	3,375	25.0	36.00	13.35
Total	10,110	5,550	6,350	23.6	32.17	13.82

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.14. Survey responses for pepper: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
New Jersey	7,000	1,129	282	---	7.50	10.00
Florida	19,940	6,980	2,618	2.5	9.47	15.70
Tennessee	2,000	500	94	---	7.36	12.35
Texas	9,160	9,160	2,290	---	7.25	15.70
Total	38,100	17,769	5,284	1.3	8.14	15.24

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.15. Survey responses for tomato: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
New Jersey	6,500	1,049	262	---	7.50	10.00
Arkansas	2,110	1,000	1,500	---	19.00	15.15
Florida	45,860	4,500	1,688	2.5	12.61	15.15
Texas	3,900	373	93	---	7.25	15.15
Total	58,370	6,922	3,543	2.3	11.10	14.37

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.16. Survey responses for spinach: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
Maryland	1,850	100	113	1.5	37.13	10.00
New Jersey	3,700	597	149	---	7.50	10.00
New York	1,250	688	186	---	15.00	10.00
Florida	234	125	63	10.0	9.10	6.00
Virginia	400	400	250	55.0	17.25	61.83
Oklahoma	2,500	2,000	1,000	10.0	10.40	17.26
Texas	6,000	6,000	12,000	---	14.50	6.00
California	6,365	4,000	2,280	30.0	18.38	6.00
Total	22,299	13,910	16,040	14.2	14.64	9.62

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.17. Survey responses for watermelon: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
New Jersey	900	145	73	---	10.00	10.00
Florida	51,710	6,000	4,500	---	16.21	21.69
Georgia	40,000	5,000	3,750	---	8.25	21.69
North Carolina	17,000	2,000	1,000	20.0	6.31	21.69
Total	109,610	13,145	9,323	1.8	10.56	21.56

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.18. Survey responses for "other" vegetables: States reporting, acreage and acreage treated with mevinphos, mevinphos applied, mevinphos's yield benefit, and control costs with and without mevinphos available (average annual), 1982-86.

Crop and State	Acreage Reported		Mevinphos applied[1] (pounds a.i.)	Yield Benefit[2] (percent)	Control Costs (dollars/acre)	
	Total	Treated			Current	Alt[3]
Brussels sprouts						
California	3,094	3,000	1,710	10.0	18.38	10.00
Peas, southern						
Tennessee	300	250	141	---	22.08	26.78
Cucumber						
Florida	15,680	784	441	---	14.72	19.90
Georgia	8,000	1,000	750	---	8.25	19.90
New Jersey	1,500	242	121	---	10.00	10.00
Texas	8,100	8,100	2,025	---	7.25	19.90
Eggplant						
Florida	2,396	240	120	---	11.15	27.82
New Jersey	1,000	161	40	---	7.50	10.00
Parsley						
Florida	910	400	1,000	15.0	35.00	27.50
Pea, english						
Wisconsin	88,140	500	125	---	15.00	6.87
Squash, summer						
Florida	14,724	1,500	563	10.0	15.34	18.91
Georgia	9,000	3,000	3,750	---	12.50	18.91
Squash, winter						
Florida	1,636	150	56	10.0	15.34	17.60
Turnip						
Florida	1,199	200	100	10.0	10.00	5.91
Artichoke						
California	10,417	10,000	5,700	45.0	18.38	10.00
Bean, lima						
Florida	242	23	17	2.5	29.62	26.39
Bean, snap						
Arkansas	3,363	1,500	2,250	---	19.00	26.70
Florida	45,374	2,269	851	2.5	14.81	26.70
North Carolina	7,000	2,000	1,000	---	6.31	26.70
Tennessee	7,000	3,500	1,750	---	16.12	26.70
Wisconsin	79,760	900	338	---	14.25	18.25
Okra						
Florida	2,440	1,855	4,174	30.0	40.50	38.70
Total	311,275	41,574	27,021	12.2	11.79	18.85

[1]Total pounds active ingredient (a.i.) applied equals average number of applications times average application rate times acres treated.

[2]Yield benefit equals the percent change in yield or marketable product per acre on acreage currently treated with mevinphos (versus registered alternatives).

[3]Average cost of chemical and/or nonchemical control alternatives that would be used on acreage currently treated with mevinphos.

Appendix Table II.19. Survey responses for field crops: Acreage, production, value (average annual), 1982-86.

Crop	Acreage	Production (1,000 cwt.)	Value of Production		
			Total (1,000 dollars)	Average (dollars/ cwt.)	Average (dollars/ acre)
Alfalfa, seed	133,862	1,085	105,390	97.13	787
Corn, field	706,200	66,735	296,925	4.45	420
Sorghum, forage	25,000	7,500	7,500	1.00	300
Sorghum, grain	20,045	894	3,469	3.88	173
Total	885,107		413,284		467

Appendix Table II.20. U.S. field crops production: Mevinphos-treated farm production and yield benefit, U.S. aggregate farm production, farm price, and yield benefit, by crop (average annual), 1982-86.

Crop	Mevinphos-treated		U. S. aggregate		
	Farm production (1,000 cwt.)	Yield benefit (percent)	Farm production (1,000 cwt.)	Farm price (dollars/ cwt.)	Yield benefit (percent)
Alfalfa, seed[1]	805	1.5	1,651	97.13	0.7
Corn, field	195	0.0	4,167,561	4.23	0.0
Sorghum, forage[2]	NA	7.5	NA	NA	0.2
Sorghum, grain[3]	20	2.5	406,537	3.94	0.0

[1]For U.S. aggregate production, annual average obtained from 1982 yield and acreage (U.S. Department of Commerce) adjusted for mevinphos-survey results. U.S. aggregate price taken from mevinphos survey average value.

[2]Florida's 25,000 acres are 0.032 of the 1982-85 U.S.D.A. average of 784,000.

[3]For U.S. aggregate production and price, annual average taken from 1982 Census of Agriculture (U.S. Department of Commerce).

SOURCES: For mevinphos-treated production and yield effects--1988-89 survey of states. For U.S. aggregate production and price--U.S. Department of Commerce, 1982 Census of Agriculture, National Summary; USDA, National Agricultural Statistics Service, Crop Production, annual issues; USDA, National Agricultural Statistics Service, Crop Values, annual issues.

Appendix Table II.21. Survey responses for fruit crops: Acreage, production, value (average annual), 1982-86.

Crop	Acreage	Production (1,000 cwt.)	Value of Production: Total (1,000 dollars)	Value of Production: Average (dollars/ cwt.)	Value of Production: Average (dollars/ acre)
Apple	83,680	12,585	135,530	10.77	1,620
Grape	676,700	49,315	1,043,366	21.16	1,542
Strawberry	19,102	7,555	332,503	44.01	17,407
Total	779,482		1,511,399		1,939

Appendix Table II.22. U.S. fruit production: Mevinphos-treated farm production and yield benefit, U.S. aggregate farm production, farm price, and yield benefit, by crop (average annual), 1982-86.

Crop	Mevinphos-treated: Farm production (1,000 cwt.)	Mevinphos-treated: Yield benefit (percent)	U.S. Aggregate: Farm production (1,000 cwt.)	U.S. Aggregate: Farm price (dollars/ cwt.)	U.S. Aggregate: Yield benefit (percent)
Apple	630	<1	80,827	11.44	0
Grape[1]	832	6	14,279	20.15	0
Strawberry	2,314	44	9,611	45.77	11

[1]Aggregate U.S. grape production and price for fresh-market only.

SOURCES: For mevinphos-treated production and yield effects--1988-89 survey of states. For U.S. aggregate production and price--USDA, National Agricultural Statistics Service, Vegetables, annual issues; USDA, National Agricultural Statistics Service, Noncitrus Fruits and Nuts, annual issues. Annual Price Behavior of Selected Vegetables.

Appendix III

Documentation and Assumptions for Survey Response Adjustment

Adjustments to the survey responses. Site numbers are given in parentheses. (as of 4/4/89). Generally, the pivotal states in assigning values to nonresponse cells are MD, IL, FL.

Connecticut:

Delaware:

(49) Cabbage--for price, used FL; for treatments per acre, given 3-4, used 3.5

Maine:

Maryland:

(14) Spinach--application costs, given: $4.50/A (air)-$6.00/A (ground), used $5.25/A. marginal benefit, given less than 2%, used 1.5%

Massachusetts:

New Hampshire:

New Jersey:

for all NJ sites, application costs, given nothing, used $5; for alternative treatment costs, given nothing, used $10.

(32) Spinach--used 19#/bushel applied to 700 crates (given) per acre.

(34) Broccoli--Given: total crop value $5,500 (too low), follow-up call got price $0.25/lb., yield 95 cwt/A

(38) Watermelon--follow-up call got price $0.10/lb., yield 150 cwt/A

(41) Strawberry--used $5/A application costs, for alternative costs, used $10

(42) Apples--calculated a price using 1982-1986 value of production $0.111 per pound; multiplied price times production (given) to arrive at value ($12,330,000); for application costs, used $5/A; for alternatives, used $10

New York:

(93) Lettuce, used 20# box; for alternative treatment costs, given no satisfactory alternative, used MD

(94) Apple--for alternative treatment costs, used $35.50

(95) Spinach--for yield, given 400-500 boxes/A, used 450 boxes/A and 19 #/box; for acreage treated, given 50-60 percent, used 55 percent; for treatments per acre, given 1-2, used 1.5.; for a.i./acre/treatment, given 0.12-0.25, used 0.18; for cost per acre per application, given $5-$10, used $10.; for loss figure, given conditional "could be rejected by processor", used zero

(133) Cabbage--for price, used 5-year average of fresh and processing; for alternative treatment costs, given nothing, used NJ

Pennsylvania:

Rhode Island:

Vermont:

Illinois:

(27) Greens--for total production, changed 750,000# to 7,500,000# to result in a yield of 30 cwt/A; a.i. application rate, given 0.5-1, used 0.75

(29) Apples--for production, given no units, used 42# bushels

Indiana:

Iowa:

Michigan:

(131) Celery--for material cost/A, given \$3.75-\$7.50, used \$5.75/A; for marginal benefit, given maybe 2%, used 2%

(132) Lettuce--a.i. application rate, given 0.25-0.5, used 0.38; marginal benefit, given no yield loss, used 5% quality loss

Minnesota:

Missouri:

Ohio:

Wisconsin:

(51) Beets, fresh--ELIMINATE--incomplete information, minor crop

(52) Celery--ELIMINATE--incomplete information, minor crop; for alternative treatment costs, used MI

(54) Snap beans--for average number of acres treated, given under 1,000, used 900

(55) Cabbage--for average number of treatments per acre, given 2-3, used 2.5; for a.i. rate of application, given 0.13-0.25 and 0.5, used 0.375; for material cost per acre, given \$1.50-\$3.00, used \$2.25; for marginal benefit, given 3-5%, used 4%; for alternative treatment costs, used IL

(56) Lettuce--for a.i. rate of application, given 0.125 to 0.5, used 0.25; for alternative treatment costs, used MI

(57) Carrots--for average number of acres treated, given 2-300, used 250; for a.i. rate of application, given 0.13-0.25 and 0.5, used 0.375; for alternative treatment costs, used IL cabbage

Alabama:

(17) Cabbage--for yield and price, given nothing, used FL

(18) Broccoli--for yield and price, given nothing, used FL

(19) Collards--for yield and price, given nothing, used GA

Arkansas:

(24) Snap beans--for yield, used FL; for mevinphos treatment costs, given NA, used \$5@(0.75/0.5) and \$2 application costs; for alternative treatment costs, given no alternatives, used FL

(25) Tomatoes--for yield, given nothing, used 1983-85 average from USDA; for mevinphos treatment costs, given NA, used \$5@(0.75/0.5) and \$2 application costs; for alternative treatment costs, given no alternatives, used FL

Florida:

(62) Corn, forage--for alternative treatment costs, used $4.79

(63) Sorghum, forage--marginal benefit, given 5-10% used 7.5%

(64) Sorghum--used 56#/bu; marginal benefit, given up to 5%, used 2.5%

(65) Lima beans--for a.i. rate of application, given 0.25-0.5, used 0.375; for material cost/A, given $2.5-$5.0, used $3.75; for marginal benefit, given expected occasional 5% loss, used 2.5%

(66) Snap beans--used 30#/bu; for marginal benefit, given expected occasional 5% loss, used 2.5%

(67) Broccoli--for a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $2.5-$5.0, used $3.75; for marginal benefit, given expected occasional 15% loss, used 7.5%

(68) Cabbage--used 50#/crate; for a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $2.5-$5.0, used $3.75; for marginal benefit, given expected occasional 60% loss, used 30%

(69) Cantaloupe--marginal benefit, given no severe losses, used 5%

(70) Carrots--marginal benefit, given occasional 10% loss, used 5%

(71) Celery--used 60#/crate; marginal benefit, given occasional 5% loss, used 2.5%

(72) Collards--for price, used GA greens; for marginal benefit, given 5-10%, used 7.5%

(73) Sweet corn--used 50#/crate

(74) Cucumbers--used 48#/crate

(75) Eggplant--used 33#/crate

(77) Lettuce--for a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $2.5-$5.0, used $3.75; for marginal benefit, given 10-15%, used 12.5%

(79) Onions, dry--for treatments per acre, given 6-8, used 7; marginal benefit, given 10-20%, used 15%

(80) Parsley--for treatments per acre, given 4-6, used 5; marginal benefit, given 10-20%, used 15%

(82) Peppers--used 28#/bu; for a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $2.5-$5.0, used $3.75; for marginal benefit, given no change in yield, used 2.5%

(83) Potatoes--for a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $2.5-$5.0, used $3.75

(84) Spinach--for marginal benefit, given a maximum 10%, used 10%

(85) Summer squash--used 48#/bu; for marginal benefit, given expected 20% loss, used 10%

(86) Winter squash--used 48#/bu; for marginal benefit, given expected 20% loss, used 10%

(87) Strawberries--used 10#/12-pt flat; for treatments per acre, given 14-21, used 17.5; marginal benefit, given 10-20%, used 15%

(88) Tomatoes--used 60#/carton; for a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $2.5-$5.0, used $3.75; marginal benefit, given maximum loss of 5%, used 2.5%

(89) Turnips--marginal benefit, given NA, used 10%; for application costs/A, given NA, used $5; for alternative treatment costs, used FL collards

(90) Watermelon--for a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $2.5-$5.0, used $3.75

(91) Cauliflower--for a.i. application rate, given 0.5-1, used 0.75;

material costs, given $5-$10.0, used $7.50

(92) Okra--for treatments per acre, given 3-6, used 4.5

Georgia:

(57) Cabbage--used 50#/crate; marginal benefit, given 10%-30% yield loss and 50%-60% quality loss, used 55%; for alternative treatment costs, given multiple alternatives, used 9 treatments@$8 treatment cost/A=$72

(58) Greens-- for alternative treatment costs, given multiple alternatives, used 9 treatments*$8 treatment cost/A=$72

(59) Watermelons-- for alternative treatment costs, given nothing, used FL;

(60) Squash--used 48#/(.555 bu); for alternative treatment costs, given nothing, used FL

(61) Cucumbers--used 48#/(1.11 bu); for alternative treatment costs, given nothing, used FL;

(134) Cantaloupe-- for alternative treatment costs, given nothing, used FL

Kentucky:

Louisiana:

(23) Greens--used 3.25#/bunch and changed units of production from bunches to dozen bunches; for acres treated, given 2-300, used 250; for no. treatments per acre, given 3-4, used 3.5;; for material and application costs, use AL collards

Mississippi:

N. Carolina:

(20) Melons (watermelons)--for yield, given nothing, used USDA 1979-1981 average; for price, used GA; for material costs per acre, used $1.31; for alternative treatment costs, given nothing, used FL

(21) Greens--for yield and price, given nothing, used NJ; for material costs, used $2.63

(22) Cabbage--for yield, given nothing, used USDA 1979-1981 average; for price, used SC; for material costs per acre, used $2.63

(135) Snap beans--for yield, given nothing, used TN; for material costs, used $1.31; for alternative treatment costs, given nothing, used FL

S. Carolina:

(15) Cabbage--for acres treated, given 95-100%, used 95%

(97) Greens--for acres treated, given 95-100%, used 95%

(98) Collards--used 20#/dozen bunches; for acres treated, given 95-100%, used 95%

(99) Apples--ELIMINATE--no mevinphos use

(100) Grapes--ELIMINATE--no mevinphos use

(101) Strawberry--ELIMINATE--no mevinphos use

(102) Peach--ELIMINATE--no mevinphos use; for production units, used 48#/bu

Tennessee:

(43) Peppers--for yield, given 1800 no units, used 1800 acres of 4

[illegible]ies, given 55-110 0, used 57.5
) [illegible] r treatment per acre, given 1-5, [illegible]

) Cabbage used 50%[illegible] [illegible] [illegible]
[illegible] quality [illegible] 5%, [illegible] treatment cost
[illegible] lives, [illegible] treatment [illegible]
8) [illegible]eans-- for alternative treatment [illegible] 75%, [illegible]
es [illegible]ed 9 treatment [illegible] treatment cost/[illegible]
[illegible] Watermelons-- for alternative [illegible] [illegible]

) [illegible]uash--used 10%/(55% bu), for alternative [illegible]
[illegible]ing, used [illegible]
1) C[illegible]umbe[illegible]s--used 45%/(1.1 bu., [illegible] alternative [illegible]
[illegible] used FL
) Cantaloupe-- for alternative [illegible]

) [illegible]eans used 5 203/bunch [illegible] [illegible] producers
[illegible]en bunches; [illegible]
[illegible]re, given 3-4 [illegible] alternative [illegible]
[illegible]

[illegible]ons (watermel[illegible]): [illegible]- for yield, given [illegible], used [illegible]
price, used [illegible], for material costs per [illegible]
ive treatment costs, given nothing, used FL
[illegible]eans- for yield and price, given nothing [illegible]
used $2.00-
[illegible]age--for yield, given nothing, used USDA 1979-1981 averages
[illegible]; for material costs per acre, used [illegible]
[illegible]p beans--for yield, given nothing, used [illegible] for mater[illegible]
[illegible].31; for alternative treatment costs, given nothing, [illegible]

[illegible]--for acres treated, given 95 100%, used 57%
--for acres treated, given 95-100% used 95
[illegible]s--used .20%/dozen bunches; for acres treated, given 95-
[illegible]

AUT[illegible]ES--ELIMINATE--no mevinphos use
[illegible]es--ELIMINATE--no mevinphos use
[illegible]rawberry--ELIMINATE--no mevinphos use
[illegible]ach--ELIMINATE--no mevinphos use; for production units, used

[illegible] yield, given 1800 [illegible] units, used 1800 acres; [illegible]

tons/A pimiento and 200 acres of 117 28#-bushels/A; for a.i. rate of application, given 1/8-1/4, used 0.1875; for material costs, given $1.41-$2.81, used $2.11; for application costs, given $4.5-$6.0 used $5.25; for alternative treatment costs, given nothing, used (average of NJ and FL) $12.35

(44) Southern peas--for yield, given 250, used .25(250 40# bu/A)+.75(0.5 ton/A); for value, given $229,500, used $185,000; for a.i. rate of application, given 1/8-1/4, used 0.1875; for material costs, given $1.41-$2.81, used $2.11; for application costs, given $4.5-$6.0 used $5.25; for alternative treatment costs, given nothing, used NC beans

(45) Greens--for acres, given 1,500, used 1,200; for yield, given 1,200, used 0.90(4 tons/A)+0.10(2,000 3.25#-bunches/A); for value, given $172,500, used $2,300,000; for a.i. rate of application, given 1/8-1/4, used 0.1875; for application costs, given $4.5-$6.0 used $5.25; for alternative treatment costs, given nothing, used NC

(46) Crucifers (renamed cabbage with crop variety code=22)--for acres, given 1,000, used 1,500; for yield, given 1,000, used 27 tons/A; for value, given $2,200,000, used $2,630,000; for a.i. rate of application, given 1/8-1/2, used 0.562; for material costs, given $1.41-$5.64, used $4.23; for application costs, given $4.5-$6.0, used $5.25; for alternative treatment costs, given nothing, used NC

(47) Snap beans--for acres, given 7,000, used 2,700 fresh and 6,300 processing, average yield, used 130 30# bu/Ac. for value, given $3,000,000, used $5,800,000; for application costs, given $4.5-$6.0, used $5.25; for alternative treatment costs, used NC

Virginia:

(130) Greens--collards, used Ag Census of 473 total acres; for yield and price, used NJ; for a.i. application rate, used 0.25#; for marginal benefit of mevinphos, used 50%/3years=17% loss/year without mevinphos; for treatment and application costs, other chemicals in mix, and alternative treatment costs, given nothing, used MD

(141) Spinach--for alternative costs, eliminate Cygon's application costs results in $61.83; for marginal yield benefit, given 50-60 percent, used 55 percent

W. Virginia:

Colorado:

(95) Field corn--production units not given, used 56# bushels; for alternative treatment costs, used $30

(96) Lettuce--used 46#/box, for price and alternative treatment costs per acre, used MI

Kansas:

Montana:

Nebraska:

N. Dakota:

Oklahoma:

(16) Spinach--for yield, used Texas
(140) Greens--for price, used TN greens

S. Dakota:

Texas:
<u>for all items with USDA 1982-86 data, used USDA acreage, production and value,</u> where USDA 1982-86 data unavailable, used survey response for 1982-86, for acres treated, used the survey response percentage applied to acres harvested; for material costs, given nothing, used $5; for application costs, given $1.50/A gy ground, $3.00/A by air, used $2.25/A; for applied with other fungicides, given nothing, used no; for alternative costs, given nothing, used FL

(103) Onions--ELIMINATE--no mevinphos use
(106) Potato--ELIMINATE--no mevinphos use
(112) Sweet corn--ELIMINATE--no mevinphos use
(115) Carrot--ELIMINATE--no mevinphos use

Wyoming:

Arizona:

(11) Lettuce--for alternative treatment costs, used FL
(12) Cole crops--for alternative treatment costs, used FL cabbage

California:

<u>for alternative treatment costs, given nothing, used FL for matching crop types, otherwise used $10 (on grape, artichoke, alfalfa (seed) and brussels sprouts)</u>

(118) Alfalfa (seed)--production changed from 900,000,000 to 90,000,000; for treatments per acre, given 1-3, used 2; a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $3.5-$4, used $3.75; application costs, given $6.00-$12.00, used $9.00; for alternative treatment costs, given nothing, used $10

(119) Artichoke--production changed from 795,300,000 to 79,530,000; for treatments per acre, given 1-2, used 1.5; a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $3-$3.5, used $3.25; application costs, given $6.00-$12.00, used $9.00; marginal benefit, given 40-50%, used 45%

(120) Broccoli--for a.i. application rate, given 0.25-0.5, used 0.38; application costs, given $6.00-$12.00, used $9; marginal benefit, given 15-20%, used 17.5%

(122) Brussels sprouts--for prices and yields, given nothing, used USDA 1979-81 averages of crop value/production/acreage; for treatments per acre, given 1-2, used 1.5; a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $3-$3.5, used $3.25; application costs, given $6.00-$12.00, used $9.00

(123) Cabbage--for acreage, production, and value, Ken Kido sent new data; for acreage treated, Kido says use 100%, for acres treated, given that out of 5 counties reporting that 2 counties "don't use mevinphos much", settle on 5,500 acres treated; for treatments per acre, given 1-2, used 1.75;

a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $3-$6, used $4.5; application costs, given $6.00-$12.00, used $9.00

(124) Cauliflower--for a.i. application rate, given 0.25-0.75, used 0.5; material costs, given $3-$3.5, used $3.25; application costs, given $6.00-$12.00, used $9; marginal benefit, given 40-50%, used 45%

(125) Celery--for a.i. application rate, given 0.25-0.5, used 0.38; application costs, given $6.00-$12.00, used $9; marginal benefit, given 35-40%, used 37.5%

(126) Grape--for treatments per acre, given 1-2, used 1.5; a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $3-$3.5, used $3.25; application costs, given $6.00-$12.00, used $9.00; for alternative costs, used $10

(127) Lettuce--for a.i. application rate, given 0.25-0.5, used 0.38; application costs, given $6.00-$12.00, used $9.00; marginal benefit, given 15-20%, used 17.5%

(129) Melons--for treatments per acre, given 1-4, used 2; a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $3-$3.5, used $3.25; application costs, given $6.00-$12.00, used $9.00; marginal benefit, given 30-35%, used 32.5%

(136) Corn--for treatments per acre, given 1-3, used 2; a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $3-$3.5, used $3.25; application costs, given $6.00-$12.00, used $9.00; marginal benefit, given 15-20%, used 17.5%

(139) Spinach--production changed from 8,050,800,000 to 80,508,000; for treatments per acre, given 1-2, used 1.5; a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $3-$6, used $4.5; application costs, given $6.00-$12.00, used $9.00

(137) Strawberries--for acreage, production, and value, Ken Kido sent new data; for acres treated, Kido sent acre-treatments, use acre-treatments divided by 3 treatments per acre, round to 3,000 acres treated; for treatments per acre, use 3; a.i. application rate, given 0.25-0.5, used 0.38; material costs, given $3-$3.5, used $3.25; application costs, given $6.00-$15.00, used $10.50; for alternative costs, used FL

(138) Onion--for application costs, given $6.00-$12.00, used $9

Nevada:

New Mexico:

Utah:

(9) Cabbage--for yield and price, nothing given, used WI; for alternative treatment costs, given nothing, used WI

Idaho:

(26) Potatoes--ELIMINATE--acreage treated=100/300,000 planted.

Oregon:

(1) Broccoli--a.i. application rate, given 0.25 aphids-0.5 worms, used 0.38; material costs per acre, given $11.37 for aphids-$22.64 for worms and aphids, used $17.00;

(2) Cauliflower--a.i. application rate, given 0.25 aphids-0.5 worms, used 0.38; material costs per acre, given $11.37 for aphids-$22.64 for worms

and aphids, used $17.00;

(3) Cucumber processing--ELIMINATE--no information beyond acreage, production, and value

(4) Cucumber fresh--ELIMINATE--no information beyond acreage, production, and value

(5) all broccoli--use site (1)

(6) Carrots--ELIMINATE--no information beyond acreage, production, and value

(7) Onions, dry--ELIMINATE--no information beyond acreage, production, and value

(8) Alfalfa seed--for marginal benefit, mevinphos costs, and alternative treatment costs, used California

Washington:

(13) Alfalfa seed--for acreage treated, given 5,000-7,000, used 6,000; for treatments per acre, given 2-3, used 2.5; for marginal benefit, given 10-15%, used 12,5%; for alternative treatment costs, given nothing, used $10

Alaska:
other territories:

APPENDIX IV

Price-quantity Relationships

The Data and Methods

The data are obtained from public sources including USDA Agricultural Statistics, Vegetable and Fruit Outlook and Situation reports, Cold Storage reports, and trade publications. The data series for this analysis are available from the authors.

The farm-level annual average price data are the ratios of annual value of production to annual total quantity of production, both reported by the USDA National Agricultural Statistics Service or NASS. The NASS estimates are compilations of cooperating states' estimates and do not include all production (as compared to a census survey). The major states, though, are included in the NASS estimates and are likely to indicate accurate changes in domestic prices.

Annual per capita use is calculated from annual domestic production, net exports, and net carry-over stocks. The per capita use (formerly known as per capita consumption) time series is not perfectly consistent. Occasionally a cooperating state will drop out of the survey or NASS will drop a crop such as asparagus and then reinstate it. In the case of lettuce, broccoli, and cauliflower, California changed its reporting schedule from annual to seasonal and rendered 1983 data not comparable to previous years. This may be important, but its impact on the continuity of the time series of data is difficult to estimate objectively.

"Other price" is the farm-level average price of the major fresh-market vegetables, excluding the commodity being regressed. All prices are deflated by the Gross National Product deflator (1982=100), and per capita disposable personal income is measured in 1982 dollars (Reagan). The other two categories of variables are continuous and binary. The binary variables are

specified as zero or one as defined below.

"Other variables": for broccoli and cauliflower; A = January 1 stocks of frozen product divided by sum of previous year's January 1 stocks plus frozen pack. B = per capita consumption of processed product divided by per capita consumption total product. For celery, lettuce, and fresh-market vegetables, A = disposable personal income per capita ($1982). For strawberry, B = per capita consumption of processed product divided by per capita consumption total product.

"Binary variables": for broccoli, A: 1986 = 1; for cauliflower, A: 1976-1988 = 1; for celery, A: 1956, 1959, 1961, 1963, 1974, 1987 = 1; B: 1955, 1958, 1962, 1968, 1978, 1983 = 1; for lettuce, A: 1961, 1970, 1972, 1975, 1977, 1980, 1984-86 = 1; B: 1955, 1971, 1973, 1978, 1982, 1988 = 1; for spinach, A: 1961, 1964, 1977 = 1; B: 1972 = 1; for cabbage, A: 1961, 1967, 1969, 1972, 1974, 1981 = 1; B: 1955, 1962, 1966, 1973, 1977, 1978 = 1; for strawberry, A: 1957, 1965 = 1; B: 1955, 1956 = 1; cantaloupe, A: 1958, 1962, 1978 = 1; B: trend 1954, 1955, . . . 1981; fresh-market vegetables, A: 1970 = 1; B: 1954-1957 = 1.

The signs on the estimated coefficients, the adjusted R-squared, and Durbin-Watson statistics suggest the models are reasonable and generally correct.

Appendix Table IV.1. Selected results from Ordinary Least Squares regression of annual average farm-level price of vegetables.[1]

Crop	Estimated coefficients: Con-stant	Per capita use	Other price	Other variables A	Other variables B	Binary variables A	Binary variables B	R-sq.[2]	DW[3]
Broccoli	33.95	-2.34	0.45	-7.79	-15.96	-3.26		0.81	1.84
Std. err.	(4.48)	(0.29)	(0.24)	(5.98)	(3.68)	(1.30)			
Cauliflower	12.18	-1.60	0.92	-0.87	1.60	3.62		0.56	1.48
Std. err.	(4.85)	(0.61)	(0.31)	(4.74)	(2.35)	(0.88)			
Celery	12.82	-1.00	0.74	-4E-04		-1.72	2.75	0.84	1.58
Std. err.	(3.22)	(0.26)	(0.14)	(8E-05)		(0.36)	(0.35)		
Lettuce	12.26	-0.34	0.63	-7E-05		-1.76	1.23	0.83	1.49
Std. err.	(1.91)	(0.11)	(0.12)	(1E-04)		(0.28)	(0.32)		
Spinach	29.80	-1.10	0.60			-2.97	4.29	0.91	1.76
Std. err.	(1.21)	(0.11)	(0.11)			(0.81)	(1.37)		
Cabbage	15.45	-0.96	0.20			-1.16	2.33	0.86	1.57
Std. err.	(2.83)	(0.12)	(0.14)			(0.36)	(0.36)		
Strawberry	45.24	-5.45			58.61	-8.73	18.2	0.87	1.70
Std. err.	(13.4)	(2.17)			(16.3)	(2.80)	(2.94)		
Cantaloupe	100.5	-1.30	0.66			-2.01	-0.04	0.81	2.75
Std. err.	(33.4)	(0.19)	(0.17)			(0.40)	(0.02)		
Fresh-market vegetables	34.48	-0.37		0.001		-2.81	2.59	0.72	2.30
		(0.04)		(2E-04)		(0.73)	(0.50)		

[1]For variable definitions and source material, see the text of Appendix B.

[2]R-squared, the multiple coefficient of determination, is adjusted for degrees of freedom.

[3]Durbin-Watson statistic indicates a two-sided test for rho equal to zero is inconclusive or fails to reject at the 10 percent level of significance for all estimated models, except celery.

SOURCE: Data available from the authors.